University of Michigan Health System

Program and Operations Analysis

Patient Service Process Analysis within Taubman Neurology and Sleep Ambulatory Care Units

Final Report

Delivered to:
Bob Davies, Chief Department Administrator
Department of Neurology
University of Michigan Health System
1500 E. Medical Center Drive, Ann Arbor, MI 48109

Project Coordinator:
Kevin DeHority, Lean Coach
Michigan Quality System
University of Michigan Health System

Supervising Faculty Member:
Professor Mark P. Van Oyen

Prepared by:
IOE 481 Project Team #5, Program and Operations Analysis
Pat Cockcroft
Sunil Narla
Alex Riley
Jaimie Sarrault

April 29, 2010
Table of Contents

Executive Summary ................................................................................................................................. 4
   Introduction ........................................................................................................................................... 4
   Taubman Neurology .......................................................................................................................... 4
   Sleep Disorders Lab ............................................................................................................................ 5

Introduction ............................................................................................................................................. 7
   Overall Project Goals .......................................................................................................................... 7
   Approach ............................................................................................................................................ 7
   Overall Expected Impact ..................................................................................................................... 8
   Support Required from Operational Entities .................................................................................... 8

Taubman Neurology .............................................................................................................................. 10
   Goals and Objectives ......................................................................................................................... 10
   Project Scope .................................................................................................................................... 10

CALL CENTER .......................................................................................................................................... 11
   Methodology ...................................................................................................................................... 11
   Simulation ......................................................................................................................................... 15
   Findings ............................................................................................................................................ 18
   Recommendations ............................................................................................................................ 20

CALL ROUTING ........................................................................................................................................ 20
   Methodology ...................................................................................................................................... 20
   Findings ............................................................................................................................................ 21
   Recommendations ............................................................................................................................ 21

PHYSICIAN DICTATIONS ...................................................................................................................... 22
   Methodology ...................................................................................................................................... 22
   Findings ............................................................................................................................................ 22
   Recommendations ............................................................................................................................ 24

Med Inn Sleep Disorders Lab ................................................................................................................. 25
   Objectives ......................................................................................................................................... 25
   Project Scope .................................................................................................................................... 25
   Methodology ...................................................................................................................................... 25
   Findings ............................................................................................................................................ 28
   Recommendations ............................................................................................................................ 29

Appendices ............................................................................................................................................... 31
List of Figures and Tables

Figure 1: Current process map of clerks and nurses receiving and returning phone calls..........................12
Figure 2: Variability of Calls Received versus Day of the Week.................................................................14
Figure 3: Variability of Calls Received versus Time of Day..........................................................................14
Figure 4: Variability of Service Time versus Time of Day...........................................................................16
Figure 5: Service Time 8:00am to 1:00pm (Log Logistic).............................................................................16
Figure 6: Service Time 1pm to 5pm (Lognormal)..........................................................................................17
Table 1: Scenario Descriptions.....................................................................................................................19
Table 2: Scenario Results Compared to Baseline..........................................................................................19
Figure 8: Scenario Comparison: Average Long Delay and Average Max Queue........................................20
Figure 9: Pareto Chart of Call Distributions..................................................................................................21
Figure 10: Effect of Policy Implementation....................................................................................................23
Figure 11: Trend in Total Number of Late Dictations.....................................................................................23
Figure 12: Process map of CPAP Prescription Process................................................................................26
Figure 13: Process Map of Updated CPAP Prescription Process.................................................................27

Appendices.........................................................................................................................................................31
   Figure 1.A: Max Queue: Out of Statistical Control.......................................................................................33
   Figure 2.A: Long Delay: Out of Statistical Control......................................................................................33
   Figure 3.A: Max Queue.................................................................................................................................35
   Figure 4.A: Long Delay.................................................................................................................................35
   Figure 5.A: Max Queue.................................................................................................................................36
   Figure 6.A: Long Delay.................................................................................................................................36
   Figure 7.A: Max Queue.................................................................................................................................37
   Figure 8.A: Long Delay.................................................................................................................................37
   Figure 9.A: Max Queue.................................................................................................................................38
   Figure 10.A: Long Delay...............................................................................................................................38
   Figure 11.A: Max Queue...............................................................................................................................39
   Figure 12.A: Long Delay...............................................................................................................................39
Executive Summary

Introduction

The Department of Neurology at the University of Michigan Health Systems (UMHS) has recognized opportunities for improvement within Taubman Neurology and the Sleep Disorders Lab. As part of the Industrial and Operations Engineering senior design class (IOE 481) a team was formed to create process maps to show the current process, and provide recommendations regarding process improvements. In order to accomplish these goals the IOE 481 project team has taken a three step approach. This three step approach consisted of the following phases: data collection, data analysis, and recommendations for both Taubman Neurology and the Sleep Disorders Lab.

Taubman Neurology

The Taubman Neurology Department identified the primary improvement opportunities as improving the number of incoming calls that are answered and decreasing the time between patient visits and physicians dictating the visits. The IOE 481 project team identified improving call center efficiency as the primary objective and analysis of physician dictations as the secondary objective.

Data collection included interviews of key personnel in the Neurology Department and queried data from the software, Business Objects. This data was used to construct a process map for further analysis. The queried data spanned February 2nd to March 22nd, 2010 and provided the team with key statistics including the number of abandoned calls, the longest delay that callers experience before their call is answered, and the maximum queue at various time intervals.

The team proceeded to the data analysis phase in which statistical software, Minitab, was used to analyze significant relationships within the data. As indicated by the data, there was a significant relationship between the maximum queue at various time intervals and the rate of abandonment. A relationship was also present between the longest delay that callers experience and the rate of abandonment. As a result of identifying these relationships, the team determined that the abandonment rate could be improved by reducing both the queue size and longest delay.

In order to accomplish this, the team constructed a simulation in ProModel to model the call center. By altering the times at which call center nurses take breaks or have an extra nurse present the team determined that the Max Queue size and Longest Delay could be significantly reduced. Specifically, the team determined that altering the lunch and break schedules abandonment rate could be improved. In addition, the team determined that by
having an extra nurse present during the peak hours of 9:00am -12:00pm and 2:00pm - 4:00pm Max Queue and Long Delay could be improved by around 50%.

The team also analyzed call routing by collecting data on where calls are transferred to and creating a Pareto chart of transferred calls. From this analysis the team determined that an extremely large amount of unnecessary calls were being received. The team believes that a new incoming call system could address this problem and thus improve important quality measures such as Long Delay, Max Queue, and Abandonment Rate.

In addition, the team addressed the secondary objective, decreasing the time between patient visits and physicians dictating these visits. During the course of the project the IOE 481 project team spoke with the Medical Director of the Sleep Disorders Lab and discovered that they had recently addressed a similar problem successfully. The Medical Director had instituted a new policy which identified consequences for sleep fellows if dictations were not submitted on time. By analyzing data before and after the new policy the IOE 481 team determined that this policy significantly reduced the time physicians were taking to dictate patient visits.

In summary, after conducting data collection and analysis on the primary and secondary objectives in Taubman Neurology the IOE 481 team makes the following recommendations for Taubman Neurology:

- Make patient callbacks during call downtimes if possible and during non-peak hours if not possible
- Alter shift schedules to minimize the number of people in queue and the longest delay; thereby reducing abandonment rate
- Consider having an extra nurse present during peak hours to handle increased call volume
- Consider implementing a policy similar to the Sleep Disorders Lab to improve patient dictations
- Consider a new incoming call system to ensure that calls are being received by the desired hospital staff

**Sleep Disorders Lab**

The Sleep Disorders Lab treats many patients who experience sleep apnea. These patients often require a prescription for Continuous Positive Airway Pressure (CPAP) equipment. Patients are not receiving CPAP equipment within the 48 hour department goal. As a result the process for issuing these prescriptions has been identified as an improvement opportunity within the Sleep Disorders Lab.
In order to better understand this process the team first interviewed key office personnel and then observed the process for processing the prescriptions. The team constructed a process map of the current situation. From this process map it was clear that the process could be improved by eliminating wasteful steps in the process. These changes were made by the Director of the Sleep Lab and a new process was implemented. The team continued to monitor the process and found that the new process was much more efficient and improved the prescription process time.

Additionally, the team talked with a Patient Services Assistant to assess the process improvements from MedEquip’s point of view. From these interviews the team determined that average wait time to schedule an appointment has been significantly reduced.

In order to maintain the improvement of the prescription process the team makes the following recommendations:

- Continue using the new prescription process rather than the old one
- Incorporate the revised prescription form found in Appendix I
- Implement a visual display in the Sleep Disorders Lab to show important quality measures in an easy to understand format
- Work closely with DME vendors to incorporate the time it takes to fill an order as a quality metric
- Conduct regular meetings to review the posted quality metrics and listen to small suggestions made by staff
Introduction

The Department of Neurology, part of the Ambulatory Care Unit (ACU) at the University of Michigan Health Systems (UMHS), has recognized improvement opportunities within two of their sub-units, Taubman Neurology and the Sleep Disorders Lab. The Taubman Neurology outpatient clinic sees patients who have not yet been diagnosed with a neurological problem. The clinic manages a wide variety of illnesses from migraines and spondylitic myelopathy to chronic meningitis and neurosarcoïdosis. They provide either long-term treatment and precise diagnoses or single consultations. The Sleep Disorders Lab diagnoses and treats patients who have problems with their sleep or level of alertness. As reported by the Clinic Manager and Medical Director, the Sleep Disorders Lab treats a high percentage of patients who are diagnosed with sleep apnea. Overall, the areas of opportunity include triage call center efficiency, physician dictations of patient visits, and Continuous Positive Airway Pressure (CPAP) equipment prescription processing. Analysis of these areas comprises the project that the UMHS has submitted to the Industrial and Operations Engineering (IOE) department through the College of Engineering at University of Michigan. An IOE 481 project team was assembled to work on this project. The team collected and analyzed data concerning incoming calls and call processing at the Neurology call center, methods for promoting timely physician dictations, and improved understanding of a DME vendor’s CPAP prescription process. Due to the disparity between the two unit’s goals, each unit will be addressed separately throughout this report. The purpose of this report is to present the IOE 481 team’s collected data, data analysis methods, and overall recommendations to Taubman Neurology and the Sleep Disorders Lab.

Overall Project Goals

The primary short-term goal of the project was to better understand and better capture baseline quality metrics while creating sustainable ongoing quality metrics for each of the units. Ultimately the team aimed to provide information enabling improved efficiency for all processes analyzed.

Approach

The team approached this project in three phases: data collection, data analysis, and recommendations. The team followed the methodology outlined below.

Project Methodology for Phase One (Data Collection):

- Identified best practices through literature searches
- Interviewed key stakeholders
• Observed of the Triage Call Center in Neurology and the Sleep Disorders Lab
• Developed process maps for each unit
• Acquired data from hospital systems

Project Methodology for Phase Two (Data Analysis):
• Created flowchart(s) for each unit
• Reviewed process maps of all key processes
• Identified waste

Project Methodology for Phase Three (Recommendations):
• Conducted root cause analysis

Details of the methodology appear in each unit section.

**Overall Expected Impact**

In conducting this study, the team used flowcharts, value stream mapping, root cause analysis, and work measurements to analyze the results. Consequently the team has provided a blueprint of the current process, including recommendations to eliminate waste and increase efficiency within the two units. Specifically, the recommendations will lead to:

• Improved patient satisfaction
• Increased patient throughput
• Lean operational processes including visual management
• Ongoing quality measures
• Detailed process mapping helping to identify the largest areas of opportunity

**Support Required from Operational Entities**

The Chief Administrator at the Department of Neurology, the project client, provided ongoing details of the problem, requirements, expectations, needed data, and contact information. He acted as a liaison between the team and other individuals to ensure full cooperation.

The Clinical Managers, or Directors, of Operations for each of the concerned departments provided ongoing details of the problem, requirements, expectations, and needed data. The project coordinator was the team’s guide and mentor. He helped maintain analytical quality and a positive relationship with the client throughout the project. He provided the team with relevant data from past projects, data collections tools, and other materials
pertaining to the successful completion of the project. The project coordinator also gave the team feedback regularly and helped develop the team’s professional skills.
Taubman Neurology

The Taubman Neurology outpatient clinic sees patients who have not yet been diagnosed with a neurological problem. The clinic manages a wide variety of illnesses from migraines and spondylitic myelopathy to chronic meningitis and neurosarcoïdosis. They provide either long-term treatment and precise diagnoses or single consultations. Currently the data, collected from their current computer software, Business Objects, indicates that less than 80% of incoming patient phone calls to nurses are answered by call management and subsequently transferred to nurses. Patients experience delays when trying to call Neurology Outpatient Services and thus inhibits the UMHS’s ability to provide quality patient services and patient care. Additionally, the Neurology Department has indicated that physicians are waiting too long before dictating patient visits into CareWeb. Currently many of the dictations are being made within one month of the patient visit according the Clinic Manager of Neurology Outpatient Services. These delays in recording dictations may reduce the quality of care that physicians are able to provide to patients, because the longer the delay, the less accurately the physicians are able to recall patient information.

Goals and Objectives

The project’s goals and objectives include:

- Improving the efficiency of processing the Taubman Neurology incoming patient calls
- Increasing the percentage of patient calls answered by call management staff to at least 80%
- Decreasing the amount of time between a patient appointment and a physician dictation of that appointment to within 48 hours

Project Scope

The scope, as is related to Taubman Neurology Outpatient Services, is defined below. The project:

- Included work completed by clerks in the Neurology call center relating to receiving patient calls
- Included dictations made by physicians in CareWeb following patient appointments
- Excluded phone calls made to and from the appointment scheduling call center
- Excluded previous goals identified by Taubman Neurology; see Appendix A
Specifically, the team studied the operations and identified improvement opportunities identified in the Objectives section above.

The team has developed recommendations, but not necessarily a final solution, regarding the processing of incoming calls to nurses received by call management and dictations made by physicians working in Neurology. Based on the findings, the team has created a blueprint, or baseline, that may be used by current departmental staff to help maintain, or improve, the level of service achieved through the implementation of the team’s recommendations.

**CALL CENTER**

Taubman Neurology has a call center that handles calls regarding medication refills, symptom discussion, and appointment scheduling. Currently this call center has not attained their goal of 80% call handling. The IOE 481 team has developed a plan to address this issue.

**Methodology**

The IOE 481 team obtained data, in accordance with the Data Collection Phase, with help from the Clinical Manager of Neurology Outpatient Services by querying their current computer software, Business Objects. Once the key data was identified, the team received data from the same source covering the dates February 2nd to March 22nd, 2010. This data consisted of the following statistics:

- Number of calls received and answered
- Average talk time
- Longest delay
- Maximum number of callers in the queue

All statistics were in 30-minute time intervals during the operating hours of 8:00am to 5:00pm.

The IOE 481 team used statistical analyses to better understand the call center processes. A process map was developed after interviewing two of call center management staff which manages the phone lines, to better understand the current state of the process, as defined in the Data Analysis Phase; see Figure 1. The team’s efforts were focused on the first three steps of the process map, *Patient Calls Neurology Desk, 1 of 3 Clerks Answers the Call*, and *Is it a New Call or a Return Call*. These three steps correspond with the first two goals set by Taubman Outpatient Services and the team.
Figure 1: Current process map of clerks and nurses receiving and returning phone calls
A simulation was then created using both the collected data and process maps previously derived. The intention of this simulation was to better understand the flow of the process and offer a way to analyze alternative arrangements and optimize the overall process. The team originally focused on understanding “Aband,” a variable in the collected data which indicates the number of dropped calls per unit of time. “Aband” needed to be reduced, since one of the team’s goals was to increase the number of patient calls answered and transferred to nurses. Further analysis of this variable focused on the correlation between “Aband” and both “Max Queue,” a variable representing the largest queue size per unit of time, and “Long Delay,” a variable representing the longest delay any customer experienced per unit of time. Using statistical software, Minitab, the team determined the correlation between variables. “Aband” and “Max Queue” had a correlation of 0.577. “Aband” and “Long Delay” had a correlation of 0.539. The correlation between “Aband” and “Ans,” a variable indicating the average amount of time that a patient waits before their call is answered, was determined to be 0.557; see Appendix B. A correlation of 0 indicates no correlation and a correlation of 1 indicates perfect positive correlation. Due to the very high correlation found between “Ans” and “Long Delay,” 0.897, and “Ans” and “Max Queue,” 0.759, “Ans” was not included in the simulation. The effect of “Ans” on “Aband” is accounted for when modeling “Long Delay” and “Max Queue.”

To analyze these two variables, “Max Queue” and “Long Delay,” the team reviewed their respective level of statistical control; see Figures 1.A and 2.A in Appendix C. This analysis indicated that both “Max Queue” and “Long Delay” are out of statistical control due to high variability in the process and outliers significantly above the upper control limit. Thus “Max Queue” and “Long Delay” have been identified as variables that have a significant effect on the overall process. By improving these variables, the process will become more efficient.

The team reviewed the process map and determined options for improving these variables. Through discussion, the IOE 481 team hypothesized that the “Long Delay” and the “Max Queue” could be reduced by adjusting the times of day that call center management takes breaks and makes appointment reminder phone calls. Adjusting these factors may allow the clerks to be more available to receive calls. The IOE 481 team simulated the incoming calls and predicted whether there were optimal times to conduct these tasks. A description of the simulation may be found in the next section.

Initial data observations indicated that the number of calls received varied greatly depending on day; see Figure 2.
Figure 2 identifies a higher call volume at the beginning of the week. The higher call volume may be handled through staff level adjustments. Further observations indicated that the number of calls received also varied greatly depending on time of day; see Figure 3.

Figure 3 identifies the call volume trend throughout the day. This fluctuation of the call volume was considered in our simulation. Considering the above, the team concluded that a different distribution for each hour time interval was needed to most accurately simulate the arrival of calls to the call center. Through research, the most relevant distribution was determined to be a Poisson distribution. Distributions were also fit to other key data including the average talk time and the average hold time.
**Simulation**

The team simulated the incoming patient call process at Taubman Neurology to better understand the existing process and determine opportunities for improvement, as previously mentioned. Ultimately, the simulation was used as a tool to analyze and identify optimal process alterations. ProModel simulation software was used in cooperation with Stat::Fit to create a model of the current incoming patient call process.

**Input Modeling**

The simulation has two locations and one entity. Calls are the entity, and the locations are the Call Queue (where customers wait to speak to a clerk), and the Clerk Station (the number of clerks at the clerk station.) Additional Clerks may be added to the Clerk Station. In the simulation Clerk Station encompasses Clerk.1 through Clerk.n where n is the number of Clerks.

A Poisson distribution was identified as the appropriate distribution for the arrival data. Therefore, the inter arrival times follow the exponential distribution and this was modeled in ProModel. Calls come in to the Call Queue according to this exponential distribution with a mean that varies by day and half hour interval. The mean number of calls received per half hour interval by day is shown in Appendix D.

The team determined the arrival rate of calls by taking the reciprocals of the mean number of calls received in each interval. The team then created a function to deal with varying inter arrival rates based on the day and 30 minute time intervals. Calls arrive to the Call Queue according to the arrival rate calculated by the function mentioned previously. If a Clerk is available at the Clerk Station, the Call is routed to the first available Clerk. If no Clerk is available, the Call waits in the Call Queue until a Clerk is available.

Once the Call is routed to the Clerk, the Clerk services the Call according to a distribution defined as the service rate, or the amount of time it takes for one Call to be processed. The service time was determined by the “Talk” times from data received from the Clinical Manager of Neurology Outpatient Services.
The “Talk” times were converted to hours and then analyzed using Stat::Fit, a type of statistical software. Upon analyzing clerk service times by time of day (see Figure 4) the team noticed that the clerk service rate appears to get significantly slower after about 1:00pm. For this reason, the team modeled the clerk’s service rates with two distributions; service times from 8:00am to 1:00pm were modeled with a Log Logistic distribution (minimum = -160.6, p = 9.0, beta = 314) while service rates from 1:00pm to 5:00pm were modeled with a Lognormal distribution (minimum = 48.2, mean = 4.8257, sigma = 0.5). Probability Distribution Functions of the Service Times are shown below in Figures 5 and 6.
Figure 6: Service Time 1pm to 5pm (Lognormal)

Once the Call is serviced, it exits the system. “Max Queue” and “Long Delay” are recorded in half hour intervals.

Statistic Collection

Statistics are kept for each Call from the point it enters the system to the point it exits the system. These statistics contribute to the overall statistics for the entire system (the Taubman Neurology Call Center). Two attributes are assigned to each Call. These attributes keep track of the wait time and service time for a particular Call. Once the Call is done waiting, the Wait Time attribute is updated and added to a global variable that keeps track of total wait time. Average Wait Time is calculated by dividing the total wait time of all Calls by the number of Calls received. A variable called Average Service Time is tracked by dividing the total service time of all Calls by the number of Calls received, similar to the Average Wait Time.

Model Assumptions

This simulation model is based on assumptions determined by observation of the process and three staff interviews:

- Staff take three staggered breaks
  - Morning break currently lasts 15 minutes and is staggered between 9:30am and 10:00am
  - Lunch break currently lasts 60 minutes and is staggered between 12:00pm and 2:00pm
  - Afternoon break currently lasts 15 minutes and is staggered between 3:00pm and 3:30pm
- A minimum of two clerks and a maximum of three clerks working at the clerk station are allowed due to temporary space limitations
- Call rates experience no seasonal variability (i.e. data from February and March can accurately model call rates for all months January to December)
• Taubman Neurology call center is open from 8:00am to 5:00pm, Monday through Thursday, and from 9:00am to 5:00pm on Friday
• Service time varies between 8:00am to 1:00pm and 1:00pm to 5:00pm
• Inter arrival rate changes every half hour interval
• All clerk have equal service rates
• No calls are abandoned

The team assumed that no calls were abandoned in the simulation. This is due to the fact that there was insufficient data to accurately model abandonment rates. After running statistical analysis on the data and working with a Senior Management Engineer at Programs and Operations Analysis experienced in simulation, the team decided that Max Queue and Long Delay were sufficient quality measures. Lowering Max Queue and Long Delay will effectively reduce the abandonment rate.

Findings

Results from Simulation

The team ran the simulation to validate and verify that it accurately represents the current process. After confirming the accuracy of the current model, the team created four scenarios. Three scenarios changed break times, and one added a part time employee. Each scenario was run for each day with 200 replications to eliminate the effect of variability on the results.

Verification & Validation

To verify the model, the team employed the following techniques:

• Compared the call flow of a simplified version of the call flow chart in Figure 1 with the flow in the model
• Stepped through model code line by line to ensure that the model logic matched that of the flow chart
• Monitored model animation ensured that the model behaved as expected
• Tracked Individual Calls to verify that they took the correct paths through the system

The model output was found to be comparable for a variety of parameters when compared to the actual data. The parameters used for comparison included average time in system, average number of customers in queue, and longest wait time.

Output Analysis

The team ran several simulations, including a baseline simulation for comparison purposes. This baseline simulation modeled the current situation – two clerks with alternating 15 minute breaks between 9:30am and 10:00am and 3:00pm to 3:30pm as well as alternating
hour long lunches between 12:00pm and 2:00pm. As mentioned earlier, reducing the “Max Queue” and “Long Delay” in each half hour interval would lead to an overall reduction of “Aband”, the quality metric the team was investigating.

Various combinations of the following three elements were used in each of the four scenarios:

1. Shifting morning break from 9:30am – 10:00am to 10:00am – 10:30am
2. Shifting lunch break from 12:00pm – 2:00pm to 11:30am – 1:30pm
3. Add a part time clerk to Call Center from 9:00am to 12:00pm and 2:00pm to 4:00pm

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Morning</th>
<th>Lunch</th>
<th>Afternoon</th>
<th>Clerks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10:00am to</td>
<td>11:30am to</td>
<td>3:00pm to 3:30pm</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>10:30am</td>
<td>1:30pm</td>
<td>3:30pm</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>9:30am to</td>
<td>11:30am to</td>
<td>3:00pm to 3:30pm</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>10:00am</td>
<td>1:30pm</td>
<td>3:30pm</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>10:00am to</td>
<td>12:00pm to</td>
<td>3:00pm to 3:30pm</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>10:30am</td>
<td>2:00pm</td>
<td>3:30pm</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>9:30am to</td>
<td>12:00pm to</td>
<td>3:00pm to 3:30pm</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>10:00am</td>
<td>2:00pm</td>
<td>3:30pm</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Scenario Descriptions

Differences in scenarios are listed above in Table 1. Table 2 and Figure 7 below show the percent improvement in each scenario when compared to the baseline simulation. By looking at the table it is clear that scenarios 1 and 4 show the greatest improvement. Scenario 1 improves both Longest Delay and Max Queue significantly for the highest volume days; Monday, Tuesday and Thursday. Although there is no improvement for Wednesday in Scenario 1, this is not as significant due to the fact that Wednesday is the lowest volume call day as seen in Figure 2. Scenario 4 demonstrates the effect that adding an extra clerk during peak times would have, as all quality measures are improved for all days.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Monday Max Queue</th>
<th>Monday Longest Delay</th>
<th>Tuesday Max Queue</th>
<th>Tuesday Longest Delay</th>
<th>Wednesday Max Queue</th>
<th>Wednesday Longest Delay</th>
<th>Thursday Max Queue</th>
<th>Thursday Longest Delay</th>
<th>Friday Max Queue</th>
<th>Friday Longest Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-16%</td>
<td>-23%</td>
<td>-22%</td>
<td>-45%</td>
<td>37%</td>
<td>57%</td>
<td>-27%</td>
<td>-23%</td>
<td>-1%</td>
<td>4%</td>
</tr>
<tr>
<td>2</td>
<td>2%</td>
<td>21%</td>
<td>-7%</td>
<td>-17%</td>
<td>6%</td>
<td>-1%</td>
<td>-8%</td>
<td>7%</td>
<td>-1%</td>
<td>4%</td>
</tr>
<tr>
<td>3</td>
<td>-18%</td>
<td>-14%</td>
<td>-13%</td>
<td>-31%</td>
<td>4%</td>
<td>-3%</td>
<td>5%</td>
<td>29%</td>
<td>6%</td>
<td>11%</td>
</tr>
<tr>
<td>4</td>
<td>-47%</td>
<td>-56%</td>
<td>-33%</td>
<td>-45%</td>
<td>-22%</td>
<td>-38%</td>
<td>-19%</td>
<td>-17%</td>
<td>-32%</td>
<td>-43%</td>
</tr>
</tbody>
</table>

Table 2: Scenario Results Compared to Baseline
The graph below gives a visual comparison of each scenario versus the baseline scenario. Since the graph takes the average across all days, it is clear that scenario’s 1 and 4 will be beneficial over the course of a week. Refer to Appendix E for figures depicting the trend of Max Queue and Long Delay over time for individual days of the week. Due to the significance difference in calls received on Wednesday the team decided to exclude Wednesday from the shift change scenarios.

**Figure 8: Scenario Comparison: Average Long Delay and Average Max Queue**

**Recommendations**

Given these findings the team recommends that Taubman Neurology take three steps to increase the amount of calls handled by the call center. The team recommends that the morning break is shifted from 9:30am – 10:00am to 10:00am – 10:30am. In addition, the team recommends that the lunch break is shifted from 12:00pm – 2:00pm to 11:30am – 1:30pm. Finally, the team recommends that a clerk is added during peak intervals of call arrival (9:00am to 12:00pm, 2:00pm to 4:00pm). The team hopes that these recommendations allow for more calls to be handled thereby allowing Taubman Neurology to provide better service to their patients.

**CALL ROUTING**

In addition to obtaining data for the simulation, the team collected data regarding call routing to better understand the call center system.

**Methodology**
In order to collect call routing data, a questionnaire was given to call management staff to fill out every day for two weeks, see Appendix F. The team successfully collected completed forms for ten days.

**Findings**

The collected questionnaire allowed the team to see the distribution of incoming calls for the call center; see Figure 9. Total calls were distributed amongst “Miscellaneous” calls, “Medication Refill” requests, “Transfer to Other” calls, “Symptom” calls, “Transfer to Appointment Scheduling,” “Appointment Reminder” phone calls made, “Call Backs,” and “Return” calls. The purpose of the call center in Taubman Neurology, as stated by call management staff, is to handle calls regarding medication refill requests, symptoms, and nurse consultations, where nurse consultations make up 5% of “Transfer to Other.” Appointment reminder calls and callbacks are phone calls which are placed from the call center to patients when the incoming call queue is zero.

![Pareto Chart of Call Distributions](image)

**Figure 9: Pareto Chart of Call Distributions**

In reference to Figure 9, “Miscellaneous” and “Transfer to Other” incoming calls make up 36.3% and 17.2% of all incoming calls, respectively. Unnecessary transfer calls make up 16.4% of all incoming calls.

**Recommendations**

With regards to call routing, the team recommends that Taubman Neurology promotes a new incoming call system. If 90% of “Miscellaneous” and “Transfer to Other” incoming calls are eliminated, the call center would receive 52.6% of its total current call volume. Reducing the call volume to this extent would result in a lower abandonment rate, lower max queue, and lower wait times.
Additionally the team noted that 11.5% of incoming calls are transferred to appointment scheduling. These calls will be eliminated once the call center is reorganized to encompass both the triage and appointment scheduling staff.

**PHYSICIAN DICTATIONS**

Taubman Neurology has a documentation system in which physicians must dictate observations from patient visits in CareWeb. Currently physicians are not attaining the department goal of dictating patient visits within 48 hours of the visit. The IOE 481 team has developed a plan to address this issue.

**Methodology**

Prior to analyzing Taubman Neurology’s physician dictation process, the IOE 481 team became aware of a similar problem in the Sleep Disorders Lab. Through interviews with the Medical Director of the Sleep Disorders Lab, the team was informed that a program had been implemented four weeks prior to the interview and has been successful up to this point.

The program implemented by the Sleep Disorders Lab Medical Director was initiated through an email sent to Sleep Fellows, which included the following consequences if physician dictations of patient visits were not made within the specified 48 hour time period:

- Mandatory citation in the personal file of the responsible clinician
- Department privileges put on probationary status, preparatory to rescinding them if the problem recurs

The email was sent after having received the proper approval from the Chief Department Administrator; see Appendix G.

The Medical Director of the Sleep Disorders Lab provided the team with data that was pulled from CareWeb by one of the office clerks. This data includes weekly reports and updates of all dated, missing citations via email to all parties concerned.

**Findings**

The team analyzed the average lateness using the data collected. This was calculated by multiplying the percentage of dictations that were a specific number of days late by the respective number of days late; see Figure 10.
Figure 10 shows an average of 9.21 days late per week before policy implementation and an average of 2.72 days late per week after policy implementation, a 70.5% improvement. However, the departmental goal is to have the dictations completed within 48 hours of the patient visit, or within two days. Even though the data collected after the policy implementation has not yet met the department goal, the trend indicates a positive outlook; see Figure 11. The policy went into effect at the beginning of week five.

Figure 11 identifies zero late dictations three weeks after policy implementation, the optimal result. Analysis of the data showed a total volume of missing dictations (a per
week average) prior to the deadline as 40.25 and 4.66 after the deadline, an 88.4% improvement.

**Recommendations**

The IOE 481 team recommends that Taubman Neurology consider this method when addressing the issue of missing physician dictations. Through statistical analysis, the method proved to be successful overall. Upon implementation of this method significant improvements were discovered in both the number of missing dictations and average lateness. However, the team has recognized that the results given are short term results and that the optimal number of weeks needed to provide recommendations with increased confidence is 30 to 40 weeks, as reported by Steve Mandell in *Metric Driven Decision Making*. Due to the time constraints collection of this amount of data by the team was not possible. Therefore, upon policy implementation, the number of late dictations and their average lateness should be monitored, either twice-weekly or weekly, to ensure quality.
Med Inn Sleep Disorders Lab

The Sleep Disorders Lab diagnoses and treats patients who have problems with their sleep or level of alertness. As reported by the Clinic Manager and Medical Director, the Sleep Disorders Lab treats a high percentage of patients who are diagnosed with sleep apnea. These patients require a prescription for Continuous Positive Airway Pressure (CPAP) equipment which is processed by the Sleep Disorders Lab office employees. Currently these prescriptions have been reported by the current Med Inn employees to require between two and four weeks before the equipment is delivered. This delay of prescription processing delays patient care and treatment.

Objectives

The IOE 481 team looked to enable the improved efficiency of processing the Sleep Disorders Lab’s patient CPAP equipment requests. Efforts by the team aimed to help the Sleep Disorders Lab reach their unit objective to increase the percentage of CPAP equipment deliveries made within two business days to >95%.

Project Scope

The scope, related to the Sleep Disorders Lab, includes work that the Sleep Disorders Lab employees perform to process CPAP prescriptions and excludes the work that the DME vendors perform to process the CPAP prescriptions. The project also excludes previous goals identified by the Sleep Disorders Lab; see Appendix A. Specifically the team studied the operations and improvement opportunities identified in the Objectives section above. The team provided recommendations regarding the CPAP equipment requests and not necessarily a final solution.

Methodology

Initially the team interviewed four key staff members who process CPAP prescription orders in the Sleep Disorders Lab. One staff member was observed processing the CPAP prescriptions. A few specific observations included the recording of paper prescriptions into CareWeb, identifying the best DME vendor, and faxing of the prescriptions to the selected vendor. After the interviews and observations, a process map was created with the help of one of the staff members; see Figure 12 below.
Figure 12: Process map of CPAP Prescription Process

1. Doctor writes and signs prescription
2. Staff receives plan from doctor
3. Staff member 1 determines DME vendor
4. Staff member 1 writes script online for DME vendor
5. Staff member 1 faxes script, insurance info, and patient location to doctor and DME vendor
6. Is the CPAP prescription a new prescription?
   - Yes: Staff member 2 writes script online for established DME vendor
   - No: Staff member 2 faxes script to established DME vendor
7. Check whether the DME vendor has returned an edited script.
8. Is script signed electronically by doctor?
   - Yes: Has DME vendor returned an edited script?
   - No: DME completes order processing
This process map illustrates many improvement opportunities, with the largest delay located in the loop surrounding *Is Script Signed Electronically by Doctor*. Upon questioning one staff member it was estimated that this entire process takes ten minutes. However, if uninterrupted the processing time would be cut in half. Further questioning summarized the following process influences:

- Answering phones and scheduling appointments are both tasks completed while processing the CPAP prescriptions
- Filling empty beds is a task which takes priority over the CPAP prescription process

The Medical Director of the Sleep Disorders Lab identified wasteful steps within the process. Due to the urgency of this issue an alternate approach to the process was implemented. The improved CPAP prescription process is illustrated in Figure 13 below.

*Figure 13: Process Map of Updated CPAP Prescription Process*
As seen in Figure 13, the revision involved a prescription form which eliminated the online scripting, electronic physician signatures, and attempted to reduce the number of prescriptions returned by DME vendors; see Appendix H. Process alterations were a result of the coded prescription, which eliminated the need for Sleep Disorders Lab staff to look up the appropriate codes, input the prescription information online, and read physician handwriting, which led to human error.

The IOE 481 team interviewed the Office Administrative Associate Supervisor of the Sleep Disorders Lab and found that the new prescription process cut the total processing time of CPAP prescriptions in half. However the delay resulting from the loop surrounding DME Vendor returns an edited script has not been resolved; see Figures 12 and 13. Though the new prescription form reduced the occurrence of returned scripts, physicians and staff members noted that they felt it was unnecessary. The team also interviewed a Patient Services Assistant at MedEquip, one of the main DME vendors which serve Sleep Disorders Lab patients.

**Findings**

Through interviewing a Patient Services Assistant at MedEquip the team learned that prescriptions sent back to the Sleep Disorders Lab as a result of missing information does not delay a patient from scheduling an appointment to pick up their CPAP equipment. Additionally, MedEquip strives to contact patients within 24 hours of receiving their prescription. Once contact is made an appointment is scheduled to pick up their CPAP equipment. As an estimate, these appointments may be made on the same day or within three days of the point of contact. The Patient Services Assistant reported that over the past five weeks, the average wait time to schedule an appointment has been two days; a significant reduction from the previous eight weeks.

Furthermore, there are instances where a patient contacts either the Sleep Disorders Lab or the DME vendor because they have yet to receive their equipment. Through the interview with MedEquip, this has been reported to be the result of manufacturer backorders. Once MedEquip sends the order to the warehouse, the warehouse manages the delivery, and MedEquip is not automatically notified of backorders.

Additionally, a list of the main reasons for sending back prescriptions to the Sleep Lab was developed. The following list consists of information that is commonly missing from prescriptions received from the Sleep Disorders Lab.

- Duration, NPI, or physician signature
• Diagnosis; or incorrect diagnosis
• Filters for set ups (A7038 & A7039)
• Tubing (A7037)
• Headgear with mask fittings (only mask is checked)
• Nasal pillow system (A7034) when nasal pillows (A7033) are checked for the nasal pillow system fitting
• Auto ASV Rate
• Heated humidifier; on new set ups

In consideration of these missing items, the Patient Services Assistant has developed an edited prescription form which resolves the issues of missing NPI numbers, head gear with mask fittings, and nasal pillow systems; see Appendix I. This new format, however, has not yet been approved.

**Recommendations**

The IOE 481 team has developed recommendations regarding the quality of information provided to DME vendors. Referencing the suggestions made by an employee at MedEquip, the team suggests that the Sleep Disorders Lab review and incorporate the revised prescription form to reduce many of the errors requiring the forms to be sent back to the Sleep Disorders Lab. In addition to this recommendation the team suggests that physicians are trained to use the prescription form properly. They should be made aware of the issues arising around the use of the prescription forms. Even so, overall the current prescription form has been very well received.

Therefore, upon implementation of these practices, the percentage of prescriptions sent back from DME vendors should be monitored, either daily or weekly, to ensure quality. This quality metric would be most effective if posted on a visual display in the Sleep Disorders Lab office for staff members and physicians to see. This display would be most effective if the current percentage, the trend of the percentage over the prior weeks, and the percent goal are posted.

An additional quality metric that the team recommends be monitored by the Sleep Disorders Lab is the time it takes to fill an order. This may be measured from the time of the appointment to the time the patient has been contacted by the DME vendor. The team recognizes that this requires continuous contact between the Sleep Disorders Lab and the DME vendor, however the contact being suggested requires a confirmation that the vendor has attempted to contact the patient. If this quality metric is only able to be collected by the Sleep Disorders Lab, and not in conjunction with MedEquip, a different approach may be taken. The Sleep Disorders Lab may identify the optimal processing time for CPAP
prescriptions and measure the amount of time between the patient appointment and the time the prescription is sent to the DME vendor. Monitoring this metric would enable the Sleep Disorders Lab to identify other causes for delayed lead time aside from manufacturer backorders. By visually tracking and identifying the reasons for delay, common themes and trends will be established, leading to continuous improvement over time. MedEquip may be used as a pilot DME vendor for this program due to its close proximity to the Sleep Disorders Lab. Any learning that occurs could then be applied to the other vendors. The optimal times chosen should be posted daily alongside the suggested metrics on a visual display in the office.

Finally, regular meetings should be conducted referencing the posted quality metrics and requesting small change suggestions by staff members. These meetings should take five to ten minutes. The visual displays and staff meetings are most effective if implemented in conjunction with each other, as reported by Mandell. The overall aim of the implementation is to ensure quality and continuous improvement.
Appendices

Appendix A: Initial department list and their respective goals

Department of Neurology

FY 2010 FGP Ambulatory Care unit (ACU)
Scorecard Quality Metrics

Med Inn Sleep Disorders Clinic and Sleep Lab
KMS Sleep Labs

1) >95% of patients CPAP equipment requests will be placed with DME vendors, within two business days after being prescribed.
2) >95% of Clinic visits will be documented in Care Web, within two business days following the visit.
3) Access to New Patient clinic appointments will be improved FY 2009

Taubman Neurology

1) Patient care-related notices and requests placed in physician mail boxes will be cleared and resolved within on week of receipt
2) Patient calls to nurses will be captured by call management staff as live calls as frequently as possible, with the goals of transferring at least 50% as live calls
3) All prescriptions (new, renewals, changes) will be resolved and submitted to pharmacies with 24-36 hours.
4) All patient clinical services will be documented in Care Web within 48 hours of the encounter with the care-giver.
5) All in-coming and out-going patient-staff telephone encounters will be randomly monitored for quality (appropriateness, efficiency, and other specified criteria).

EMG Lab

1) All inpatient transport and portable EMG order entries (Care Link and manual) will be completed within 24 hours of receipt.
2) All patients will complete a standard education module before EMG testing is administered; this education and results will be documented in Care Web.
## Appendix B: Correlation Matrix

<table>
<thead>
<tr>
<th></th>
<th>Date</th>
<th>Ans</th>
<th>Lvl</th>
<th>Offered</th>
<th>Handled</th>
<th>Abandoned</th>
<th>Trans In</th>
<th>Trans Out</th>
<th>Talk</th>
<th>Work</th>
<th>Hold</th>
<th>Hndl</th>
<th>Long Delay</th>
<th>Max Queue</th>
<th>Perc Aband</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ans</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.073</td>
<td>0.067</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lvl</td>
<td>0.121</td>
<td>-0.548</td>
<td>0.002</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Offered</td>
<td>0.009</td>
<td>0.441</td>
<td>-0.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handled</td>
<td>0.018</td>
<td>0.147</td>
<td>-0.246</td>
<td>0.833</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aband</td>
<td>-0.037</td>
<td>0.557</td>
<td>-0.303</td>
<td>0.539</td>
<td>0.0878</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trans In</td>
<td>0.001</td>
<td>0.106</td>
<td>-0.187</td>
<td>0.298</td>
<td>0.26</td>
<td>0.159</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trans Out</td>
<td>0.081</td>
<td>-0.022</td>
<td>-0.054</td>
<td>0.422</td>
<td>0.588</td>
<td>-0.083</td>
<td>0.121</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Talk</td>
<td>-0.054</td>
<td>0.297</td>
<td>-0.324</td>
<td>0.064</td>
<td>0.041</td>
<td>0.095</td>
<td>0.166</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work</td>
<td>-0.039</td>
<td>0.159</td>
<td>-0.149</td>
<td>-0.004</td>
<td>-0.06</td>
<td>0.094</td>
<td>0.035</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hold</td>
<td>0.044</td>
<td>0.137</td>
<td>-0.065</td>
<td>-0.038</td>
<td>-0.083</td>
<td>0.055</td>
<td>0.032</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hndl</td>
<td>-0.042</td>
<td>0.299</td>
<td>-0.286</td>
<td>0.02</td>
<td>-0.043</td>
<td>0.128</td>
<td>0.118</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long Delay</td>
<td>-0.06</td>
<td>0.897</td>
<td>-0.497</td>
<td>0.484</td>
<td>0.232</td>
<td>0.539</td>
<td>0.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max Queue</td>
<td>-0.066</td>
<td>0.759</td>
<td>-0.607</td>
<td>0.645</td>
<td>0.424</td>
<td>0.577</td>
<td>0.221</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perc Aband</td>
<td>-0.029</td>
<td>0.302</td>
<td>-0.125</td>
<td>0.1</td>
<td>-0.271</td>
<td>0.774</td>
<td>0.009</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cell Contents**: Pearson Correlation

**P-Value**

*This data helps to identify which variable, if any, affect each other. Please see report for further analysis.*
Appendix C: Control Charts for “Max Queue” and “Long Delay”

Figure 1.A: Max Queue: Out of Statistical Control

Figure 2.A: Long Delay: Out of Statistical Control
### Appendix D: Average Calls Received at Taubman Neurology Call Center by Time Interval

<table>
<thead>
<tr>
<th>Time Interval</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 to 8:30</td>
<td>10.5</td>
<td>7.9</td>
<td>6.7</td>
<td>6.1</td>
<td>4.4</td>
</tr>
<tr>
<td>8:30 to 9</td>
<td>11.1</td>
<td>9.1</td>
<td>9.4</td>
<td>6.7</td>
<td>5.4</td>
</tr>
<tr>
<td>9 to 9:30</td>
<td>12.9</td>
<td>12.4</td>
<td>10.7</td>
<td>9.6</td>
<td>17.3</td>
</tr>
<tr>
<td>9:30 to 10</td>
<td>13.3</td>
<td>12.6</td>
<td>12.9</td>
<td>12.4</td>
<td>13.3</td>
</tr>
<tr>
<td>10 to 10:30</td>
<td>14.4</td>
<td>9.1</td>
<td>11.4</td>
<td>10.9</td>
<td>9.6</td>
</tr>
<tr>
<td>10:30 to 11</td>
<td>14.9</td>
<td>12.6</td>
<td>9.9</td>
<td>11.9</td>
<td>10.9</td>
</tr>
<tr>
<td>11 to 11:30</td>
<td>18.4</td>
<td>13.7</td>
<td>13.7</td>
<td>11.4</td>
<td>12.3</td>
</tr>
<tr>
<td>11:30 to 12</td>
<td>12.7</td>
<td>9.7</td>
<td>11.0</td>
<td>9.7</td>
<td>10.4</td>
</tr>
<tr>
<td>12 to 12:30</td>
<td>11.0</td>
<td>8.6</td>
<td>8.9</td>
<td>7.0</td>
<td>8.7</td>
</tr>
<tr>
<td>12:30 to 1</td>
<td>12.4</td>
<td>8.6</td>
<td>7.9</td>
<td>9.4</td>
<td>9.6</td>
</tr>
<tr>
<td>1 to 1:30</td>
<td>11.3</td>
<td>10.1</td>
<td>10.9</td>
<td>9.6</td>
<td>9.3</td>
</tr>
<tr>
<td>1:30 to 2</td>
<td>14.9</td>
<td>14.1</td>
<td>10.3</td>
<td>13.3</td>
<td>10.9</td>
</tr>
<tr>
<td>2 to 2:30</td>
<td>12.4</td>
<td>14.1</td>
<td>9.7</td>
<td>13.1</td>
<td>10.4</td>
</tr>
<tr>
<td>2:30 to 3</td>
<td>14.4</td>
<td>13.3</td>
<td>9.9</td>
<td>10.0</td>
<td>12.0</td>
</tr>
<tr>
<td>3 to 3:30</td>
<td>11.6</td>
<td>10.9</td>
<td>9.9</td>
<td>11.0</td>
<td>10.9</td>
</tr>
<tr>
<td>3:30 to 4</td>
<td>11.9</td>
<td>12.1</td>
<td>10.1</td>
<td>10.3</td>
<td>7.9</td>
</tr>
<tr>
<td>4 to 4:30</td>
<td>9.1</td>
<td>10.0</td>
<td>8.6</td>
<td>6.0</td>
<td>5.9</td>
</tr>
<tr>
<td>4:30 to 5</td>
<td>8.4</td>
<td>6.9</td>
<td>7.1</td>
<td>6.0</td>
<td>5.9</td>
</tr>
</tbody>
</table>
Appendix E: Simulation Results

Monday

Figure 3.A: Max Queue

Figure 4.A: Long Delay
Tuesday

Figure 5.A: Max Queue

Figure 6.A: Long Delay
Wednesday

Figure 7.A: Max Queue

Figure 8.A: Long Delay
Thursday

Figure 9.A: Max Queue

Figure 10.A: Long Delay
Figure 11.A: Max Queue

Figure 12.A: Long Delay
Appendix F: Questionnaire Given to Call Center Staff

**MONDAY**

<table>
<thead>
<tr>
<th>Start Time:</th>
<th>End Time:</th>
</tr>
</thead>
</table>

Please indicate what the purpose of each call is by making a dash under the relevant statement:

- **Symptom Call:**
- **Medication Refill:**
- **Transfer Call to Appointment Scheduling:**
- **Transfer Call to Other (Please indicate the department transferred to bel**

Please indicate below where calls under "Other" (above) were transferred to:

1
2
3
4
5
6
7
8
9
10

Please indicate the number of calls you made today for each of the following:

<table>
<thead>
<tr>
<th>Appointment reminders:</th>
<th>Time calls were made: (Circle One)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start of Shift</td>
<td>End of Shift</td>
</tr>
<tr>
<td>Throughout the Day</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Callbacks:</th>
<th>Time calls were made: (Circle One)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start of Shift</td>
<td>End of Shift</td>
</tr>
<tr>
<td>Throughout the Day</td>
<td></td>
</tr>
</tbody>
</table>
Dear Sleep Fellows,

As you know, a number of sleep clinic dictations have been done late, up to a month or sometimes more. This threatens good care because material cannot be remembered that long accurately, and because other physicians may need the information in the interim. I am told also that delays longer than 48 hours for clinic notes violate Office of Clinical Affairs policies.

To eliminate this problem, we will follow the following guidelines, starting now:

1. ALL outstanding dictations for patients seen on Thurs, Feb 4, or earlier will be completed by Monday, February 8, at 7:00 AM.

2. Thereafter:

   all dictations are to be completed (not necessarily signed) on the day the patient is seen;

   dictations completed on a subsequent day, but still within 48 hours (business days) after the patient visit, will still be acceptable on an exceptional basis at the discretion of the Sleep Center Director;

   dictations that are not an acceptable exception as above, or any dictation not completed within 48 hours (business days) after the patient visit, will result in mandatory citation in the personal file of the responsible clinician, and sleep clinic privileges will be put on a probationary status, preparatory to rescinding them if the problem recurs.

Thank you,
Appendix H: Current Prescription Form

PATIENT: __________

SLEEP DISORDERS CLINIC/LABORATORY
EQUIPMENT/SUPPLIES ORDER

Please CHECK: [ ] NEW SET-UP [ ] PRESSURE CHANGE [ ] SUPPLIES

DIAGNOSIS:
[ ] 327.23 Obstructive Sleep Apnea APNEA/HYPOPNEA INDEX __________
[ ] 327.21 Central Sleep Apnea
[ ] 327.24 Idiopathic Sleep Related Non-Obstructive Alveolar
Hypoventilation
[ ] 327.26 Sleep Related Hypoventilation/Hypoxemia
in Conditions Classified Elsewhere
[ ] 327.27 Central Sleep Apnea in Conditions
Classified Elsewhere
[ ] 327.29 Other Organic Sleep Apnea
[ ] 786.04 Cheynes Stokes
SECONDARY DIAGNOSIS: [ ] 401.9 Hypertension [ ] 780.53 Hypersomnolence

EQUIPMENT
[ ] CPAP (E0601) or [ ] Auto CPAP (E0601) Pressure ________ cmH2O
[ ] BILEVEL (E0470) or [ ] Auto BILEVEL (E0470) Pressures ________ cmH2O
[ ] BILEVEL with Back-up Rate (E0471) Rate: ____ Pressures ________ cmH2O

[ ] AUTO SV (E0471) Max IPAP ______ cmH2O Min IPAP ______ cmH2O
EPAP ______ cmH2O
Rate ____ Alarm: [ ] Yes [ ] No Description: ________
[ ] HEATED HUMIDIFIER (E0562)

[ ] OXYGEN CONC. (E1390) Bleed ____ LPM into equipment at above pressures

[ ] REPAIR OR REPLACE EQUIPMENT [ ] OTHER _______________________

The following disposable supplies are necessary for the proper use of the equipment:
SUPPLIES: [ ] Refill ____ times per year [ ] Dispense disposable supplies
per patient request

COMMENTS:
A7027 [ ] Combination Oral/Nasal Mask
A7028 [ ] Oral Cushion
A7029 [ ] Nasal pillows-comb mask
A7030 [ ] Full Face Mask
A7031 [ ] Full Face Cushion
A7032 [ ] Nasal Cushion
A7033 [ ] Nasal Pillows
A7034 [ ] Nasal Mask/Nasal Pillow System
A7035 [ ] Headgear
A7036 [ ] Chinstrap
A7037 [ ] Tubing
A7038 [ ] Disposable Filters
A7039 [ ] Perm. Filters
A7044 [ ] Oracle Interface
A7046 [ ] Humidifier Chamber
A4604 [ ] Heated tubing (for Thermosmart units)

DURATION OF USE: _____ months

PHYSICIAN NAME: ___________________________ NPI#: ___________________________

PHYSICIAN
SIGNATURE ___________________________ DATE __________
Appendix I: Revised Current Prescription Form

SLEEP DISORDERS CLINIC/LABORATORY
EQUIPMENT/SUPPLIES ORDER

Please CHECK: [ ] NEW SET-UP [ ] PRESSURE CHANGE [ ] SUPPLIES

DME Provider: ____________________

DIAGNOSIS: APNEA/HYPOPNEA INDEX ____________
[ ] 327.23 Obstructive Sleep Apnea
[ ] 327.21 Central Sleep Apnea or Complex Sleep Apnea
[ ] 327.24 Idiopathic Sleep Related Non-Obstructive Alveolar Hypoventilation
[ ] 327.26 Sleep Related Hypoventilation/Hypoxemia in Conditions Classified Elsewhere
[ ] 327.27 Central Sleep Apnea in Conditions Classified Elsewhere
[ ] 327.29 Other Organic Sleep Apnea
[ ] 786.04 Cheynes Stokes

SECONDARY DIAGNOSIS: [ ] 401.9 Hypertension [ ] 780.53 Hypersomnolence

EQUIPMENT
[ ] CPAP (E0601) Pressure ________ cmH2O
[ ] AUTO CPAP (E0601) Pressure ________ cmH2O
[ ] BILEVEL (E0470) Pressures ________ cmH2O
[ ] AUTO BILEVEL (E0470) Pressures ________ cmH2O
[ ] BILEVEL w/BUR (E0471) Pressures ________ cmH2O Rate: _____
[ ] AUTO SV (E0471) Max IPAP ______ cmH2O Min IPAP ______ cmH2O EPAP ______ cmH2O Rate ___ Alarm: [ ] Yes [ ] No Description: __________
[ ] HEATED HUMIDIFIER (E0562)
[ ] OXYGEN CONC. (E1390) Bleed _____ LPM into equipment at above pressures
[ ] REPAIR OR REPLACE EQUIPMENT [ ] OTHER __________________

The following disposable supplies are necessary for the proper use of the equipment:

SUPPLIES: [ ] Refill _____ times per year [ ] Dispense disposable supplies per patient request

COMMENTS: ___________________________________________________________________

Mask* & headgear* Other misc. supplies
A7027 & A7035 [ ] Combination Oral/Nasal Mask & headgear A7028 [ ] Oral Cushion
A7030 & A7035 [ ] Full Face Mask & headgear A7029 [ ] Nasal-comb
A7034 & A7035 [ ] Nasal Mask/Nasal Pillow System & headgear A7031 [ ] Full Face Cushion
A7044 & A7035 [ ] Oral interface A7033 [ ] Nasal Pillows
A7037 [ ] Tubing* A7036 [ ] Chinstrap
A4604 [ ] Heated tubing* (Thermosmart units) A7046 [ ] Humidifier Chamber
A7038 [ ] Disp. Filters* A7039 [ ] Perm. Filters*
*supplies required at all new set ups

Ronald Chervin, M.D., NPI# 1811086670 Neeraj Kaplish, M.D., NPI# 1285751305
Flavia Consens, M.D., NPI# 1891884755 Linda Selwa, M.D., NPI# 1831270966
DURATION OF USE: [ ] 12 months OR [ ] other ___________________________

PHYSICIAN NAME: ___________________________ NPI#: ___________________________

PHYSICIAN SIGNATURE ___________________________ DATE ___________________________