Analysis of the Patient Scheduling and Calling Process in the Physical Medicine and Rehabilitation Department of the University of Michigan Health System

Final Report

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# Table of Contents

**Executive Summary**
- Goals and Objectives .................................................. I
- Methods and Findings ................................................... I
- Design Criteria ............................................................ II
  - Database Tool ......................................................... II
  - Simulation Tool ....................................................... III
- Recommendations ......................................................... III

**Introduction** ............................................................ 1
**Background** .............................................................. 1
**Key Issues** ............................................................... 2
**Goals & Objectives** ................................................... 3
**Project Scope** ............................................................ 3
**Methods and Findings** ............................................... 3
  - Literature Search ....................................................... 3
  - Interviews and Observations ....................................... 4
    - MedRehab Canton interview and observation .................. 4
    - Spine – Burlington interview and observation ................ 4
    - C.S. Mott Children’s Hospital interview and observation ... 5
    - MedRehab Briarwood Building 4 interview and observation . 5
    - University Hospital observation .................................. 5
    - MedRehab Briarwood Building 2 interview ........................ 5
    - Call Log Data .......................................................... 6

**Software Design and Implementation** ............................ 6
  - Database Tool Design ................................................. 6
  - Search Criteria ........................................................ 6
  - Other Design Considerations ........................................ 6
    - Automatic loading of sub-diagnoses and locations .......... 8
    - “Comments” sections for therapists and locations .......... 9
    - Automatic population of therapist information in add/edit tab 10
  - Database Tool Implementation ..................................... 11
  - Simulation Tool Design .............................................. 12
    - Overview ............................................................. 12
    - Modeling Decisions ............................................... 12
      - FTE Levels ......................................................... 12
      - Priority ............................................................ 13
      - Data Aggregation ................................................ 13
  - Simulation Tool Implementation .................................... 13

**Recommendations** ................................................... 13
**Impact** ................................................................. 14
Appendix A – Diagram of Project Goals & Tasks

Figures and Tables

Fig. 1 – The main determining factor for whether a patient can schedule an appointment is whether the call agent’s location treats the patient’s diagnosis.

Fig. 2 – a) Selecting the “Occupational Therapy” diagnosis automatically loads all related sub-diagnoses. b) Selecting the “Men’s Health” diagnosis automatically filters the list of locations to just Canton and University Hospital.

Fig. 3 – a) Double-clicking on a therapist’s name in the search results brings up a new window with free-text comments about that therapist. b) Double-clicking on a location name in the search results brings up a new window with free-text comments about that location.

Fig. 4 – Selection of therapist “Joey” in the “Add/Edit Therapist” tab automatically populates all of the controls on the form with Joey’s attributes.

Fig. 5 – Navigating to the Add/Edit tab of the database tool forces the user to enter the password in order to add or edit any entries in the database.
Executive Summary

Patients who call any of the six locations (Briarwood 2, Briarwood 4, Burlington, Canton, Mott, and University Hospital) within the Physical Medicine and Rehabilitation (PM&R) Department of the University of Michigan Health System may experience long wait times (up to 15 minutes) for call agent service and may have their call transferred to another location. These two potential events within the call experience decrease patient satisfaction with the call and appointment scheduling processes, ultimately decreasing the department’s patient retention rate and revenue. The Senior Clerical Supervisor of the PM&R Department has proposed that the phones at each of the six locations may be virtually linked such that a call arriving at one location may be automatically rerouted to any idle phone at another location if the phones at the original destination location are busy. This change would decrease patient wait times in the call queue. However, the call agents across all six locations do not have enough knowledge about the therapists and appointment scheduling procedures at each of the other locations to be able to adequately serve patients. Since call agents may not be able to schedule patient appointments at the “best” times (“best” being a subjective measure), therapists also have low fill rates (the proportion of time that a therapist is busy).

Goals and Objectives

The primary goal is to increase patient satisfaction by reducing patient call wait time and service time. Thus, the Senior Clerical Supervisor asked a team of IOE 481 students to create a therapist database look-up tool that will allow call agents to look up information about therapists and appointment scheduling processes at each of the six locations. This tool will enable call agents at any location to adequately serve patients regardless of the patient’s desired appointment location and regardless of the call agent’s work location. This change decreases patient wait times, thus increasing patient satisfaction, retention rate, and the department’s revenue. Additionally, this change allows call agents to schedule patient appointments at “better” times, which will increase therapist fill rates. Since, the Senior Clerical Supervisor will have the phones linked, which creates a virtual centralized call center, the team was asked to create a simulation tool that will show the average patient call wait time and how it varies through time. The simulation tool will allow the Senior Clerical Supervisor to change the call agent’s schedule to easily see the impact of shifting, hiring, or reallocating full-time equivalents (FTEs) on patient wait times.

Methods and Findings

At the outset of the project, to gain a clear understanding of calling and scheduling processes, the team conducted a literature search. The team found three articles from past IOE senior design projects which included background information on scheduling processes, factors that affect therapist fill rates, and information on how the PM&R department previously operated. However, these articles did not provide any information that fundamentally changed the team’s thought processes about how to fulfill the Senior Clerical Supervisor’s request.

To determine the necessary design elements of the therapist database look-up tool (“database tool”), the team interviewed and observed 13 total employees across the six locations within the department. These employees included therapists, call agents, and other clerical staff. In these
interviews and observations, the team learned about the various call and scheduling processes at each location. Some key findings from these interviews and observations include the following:

- Searching by diagnoses and locations alone for matching therapists would provide many irrelevant results
- Therapists and locations each have unique complications that affect the scheduling process
- Each call agent may not have perfect knowledge of the relationships between specific diagnoses and specific sub-diagnoses
- Average patient call wait time and service time is not governed by an elementary statistical distribution
- Call log data is only available as unformatted PDF files

In addition, the team assumed that the target audience of the database tool would both be unfamiliar with Microsoft Access and not be as willing to use the database tool if adding and editing of records were not intuitive and easy.

**Design Criteria**

The team gathered and synthesized all of the information gained through the aforementioned interviews and observations to devise design criteria for the database and simulation tools. Some of the major features of the designs are discussed below.

*Database Tool*  
Since searching by diagnosis and location alone would provide many irrelevant results, the database tool must have additional search parameters to further refine the search results. A combination of information from the team’s interviews and from consultation with the Senior Clerical Supervisor led to the creation of the following list of search criteria:

- Diagnoses that each therapist can treat
- Therapist location
- Whether a patient is new or returning (revisit patient)
- Whether a patient is adult or pediatric
- Whether a patient is covered by Medicare
- Therapist (general) work schedule

The unique complications of individual therapists and locations led to the implementation of a free-text “comments” section for each therapist and location where additional information about the entity may be stored. For example, the comments section may hold such information as the fact a therapist is temporarily injured and has limitations in ability to treat patients. Also, since each call agent may not have perfect knowledge about each diagnosis and sub-diagnosis, the database tool automatically loads the relevant sub-diagnoses upon selection of a specific diagnosis. For example, if the diagnosis “Spine” is selected, the database tool will automatically show the sub-diagnoses that are associated with the “Spine” diagnosis. Also, selection a specific
diagnosis also filters the locations to leave only the locations that have therapists which can treat the diagnosis. Since the intended users of the database tool may not have familiarity or willingness to work with Microsoft Access, the database tool will utilize a user-friendly interface that allows users to search a therapist database and add and/or edit entries in this database without having to deal with the Microsoft Access database file directly.

**Simulation Tool**
To create the simulation tool, the team analyzed call log data to determine which factors affect the patient call wait and service time. The factors taken into account in this tool are the intra-day, intra-week, and intra-year (otherwise known as seasonal) variances that affect how a schedule may evolve throughout these periods. Intra-day considerations are handled by modeling call arrival rates as dynamic throughout the day and allowing for different call agent schedules. Intra-week and intra-year considerations are handled by allowing the Senior Clerical Supervisor to discriminate by which data they wish to input into the model.

Further considerations about nuances of the UMHS call agent’s work are noted as well. For instance, some call agents are only partial FTEs (full time equivalents), meaning they only spend a portion of their day as a call agent, and spend the rest in another job. This factor can be captured in a simulation, but not in a queuing model. Another consideration is priority for these partial FTE call agents. Some call agents prioritize answering calls while others prioritize other tasks they may have that come up through the workday. The simulation tool allows for these differences to be captured in a sensible way.

**Recommendations**

The team recommends this database tool be placed on the department’s share drive so that everyone has access to it. The database tool is not equipped with all the current search criteria and a PM&R staff member should enter the information that was not included. The team also recommends that the Senior Clerical Supervisor be the only person with access to the simulation tool as that is a managerial planning tool and has no involvement in the calling or scheduling processes themselves.
Introduction

The Physical Medicine & Rehabilitation (PM&R) Department in the University of Michigan Health System (UMHS) is not utilizing therapists’ time efficiently due to the inefficient scheduling processes carried out by call agents at the six locations within the department, according to the department’s Senior Clerical Supervisor. These locations are: MedRehab Briarwood Building 2, MedRehab Briarwood Building 4, Spine – Burlington, MedRehab Canton, C.S. Mott Children’s Hospital, and University Hospital. The department would like to determine whether improvements are possible with respect to call agent access to information, which will help the department with their ultimate goal of increasing patient satisfaction with the call and scheduling processes and access to treatment. According to the Senior Clerical Supervisor, patient satisfaction with these processes is strongly linked to the length of time spent waiting for a call agent service. The team has found from the Senior Clerical Supervisor that patients may wait up to 15 minutes for call agent service only to find out that they have called the wrong location and will need to wait again for call agent service as their call is transferred to the appropriate location. Virtually linking the phones across the department will allow call agents at any location to answer patient calls that arrive at all locations and eliminate the need to transfer patient calls between locations, effectively decreasing patient wait times. The Senior Clerical Supervisor has previously proposed to move to a virtual centralized call center in which the phones at all locations are linked, but the call agents’ lack of knowledge about the therapists and scheduling procedures at all of the locations precluded this change. However, if call agents have increased access to information, they will be able to handle patient calls to schedule appointments regardless of the location at which the patient wishes to receive treatment and regardless of the location at which the call agent is working.

The Senior Clerical Supervisor asked a team of IOE 481: Hospital Practicum students at the University of Michigan to build a computer program that allows the call agents to look up therapist information across all locations to avoid transferring patients to call agents in other locations. She also asked the team to identify variations and inefficiencies in the scheduling processes between different locations and to determine the potential performance gains of an previously proposed new virtual centralized call center. After performing these tasks, the team has recommended a program that can be integrated into the existing systems so all call agents can assist patients of all diagnoses and location preferences. The team will also provide a quantitative analysis of performance gains of a virtual centralized call center using a simulation program. Because of the aforementioned program, therapist fill rates (the portion of a therapist’s schedule filled with appointments) will increase as call agents are better able to schedule patients. This report presents the team’s methods, findings, conclusions, and recommendations for enabling the creation of a virtual centralized call center.

Background

Call agents currently work independently in each of the six locations within the PM&R department in UMHS to handle patient calls and schedule patient appointments.
This process is shown in Figure 1 and begins with a patient calling one of the locations and ends with either a scheduled appointment or instructions for the patient to call a different location.

Figure 1: The main determining factor for whether a patient can schedule an appointment is whether the call agent’s location treats the patient’s diagnosis.

Each of the locations is independent in that each handles only its own calls. With this setup, several locations’ call agents could be idle while another location has a long queue of callers waiting. Based on previously collected internal data, the department drops calls at a rate as high as 15.3% and has a service level (defined as the sum of calls handled, abandoned by the caller, and routed out) as low as 58% in some locations at some periods, while their targets for these metrics are 4% and 80%, respectively.

Additionally, therapists in the department currently have low fill rates – anecdotally from the client, these numbers can be as low as 30% on any given day. The Senior Clerical Supervisor also would like average fill rate to reach at least 90%. These low fill rates are a result of gaps in therapist schedules between appointments. Lower fill rates lead to wasted cost in paying for therapists’ idle time.

The relationships between these goals and outcomes may not be immediately clear; Appendix A provides a diagram that organizes the project goals and objectives to show how achieving lower-level goals help achieve broader goals.

**Key Issues**

This project is motivated by the following issues with the current system of handling calls and scheduling patient appointments in the PM&R department of UMHS:

- Lack of access to therapist information causing major inefficiencies
- High rate (up to 15.3% at some locations) of dropped calls due to high wait times
- Low service level (as low as 58% at some locations) as defined in background
- High patient dissatisfaction with the calling and scheduling processes as evidenced by patient surveys
- Low fill rates for therapists causing an unnecessary outflow of wages
Goals and Objectives

The primary goal of this project is to increase revenue for the PM&R Department, specifically by increasing patient satisfaction with respect to interactions with the PM&R Department’s call system and scheduling processes and to increase therapist fill rate. Ultimately, achieving these goals will increase profit for UMHS. To achieve these impacts, the team would like to increase patient retention and attract new patients to UMHS, leading to greater revenue for the health system. To achieve these goals, the team has developed the following objectives:

- Create a program for call agents allowing them to look up therapists by specialty and location. This program will allow call agents to schedule patients for other locations and further reduce the time that a call agent must spend looking up doctor information manually.
- Analyze the potential performance gains of a virtual call center design for the IT department to implement using a time-dependent queuing model.
- Observe the patient call and scheduling processes at each of the six locations to identify additional inefficiencies in and variations between locations.

Project Scope

This project only addresses modifying the processes of handling patients’ calls and of scheduling appointments in the PM&R department. The call process begins with the patient dialing the number and ends with the ending of the call. The scheduling process begins with an arrival of a physician order and ends with entry of a scheduled appointment.

This project excludes the events after an appointment is scheduled or before the physician order is submitted. Also excluded are modifications and analysis of the Cadence system, specific recommendations for call agent scheduling, and analysis of call and scheduling processes for other departments in UMHS.

Methods and Findings

Our methods included a literature search from past similar initiatives; interviews and observations of call agents and other clerical staff, and clinical staff; and collection of call log data from the Senior Clerical Supervisor. The findings relate to the design of the software and are further described below.

Literature Search

The team conducted a literature search of past IOE 481 senior design project final reports to find background information on scheduling processes, factors that affect therapist fill rates, and information on the PM&R department’s operations. These articles included:

- “Analysis of Pediatric Acute Physical and Occupational Therapy Patient Care Delivery” by Lauren Hood, Amanda Metviner, Andrew Nicholls, and Kristin Roth – Winter 2010
• “Analysis of New Patient Access to Appointments in the Adult and Child Ambulatory Psychiatry Clinics” by An Cao, Sam Ditter, Ryan Minnema, and Maria Morales – Winter 2010
• “Analysis of Lead Time to Day of Appointment in Adult Ambulatory Psychiatry Clinics” by Jeremy Chan, Aaron Chow, and Siew Jin Leow – Fall 2007

However, these articles did not provide any information that fundamentally changed the team’s thought processes about how to fulfill the Senior Clerical Supervisor’s request. The majority of information that affected the team’s actions and thought processes came from interviews and observations of PM&R personnel at the various locations within the department.

Interviews and Observations

Extensive interviews with and observations of call agents and clerical staff at each of the six locations within the PM&R Department (MedRehab Briarwood Building 2, MedRehab Briarwood Building 4, Spine – Burlington, MedRehab Canton, C.S. Mott Children’s Hospital, and University Hospital) gave the team important information that guided the development of the database tool.

MedRehab Canton interview and observation
The team simultaneously observed and interviewed two employees at MedRehab Canton – a clinical supervisor and a call agent. During the interview, the team found that the call agents were very receptive to the idea of using a database look-up tool. The call agents provided the team with a basic understanding of the scheduling process. Specifically, they told the team that they utilize several therapist-specific considerations, such as a patient “blacklist” for patients who stalk certain therapists. From this information, the team decided that the database look-up tool would need to have a free-text “comments” section for each therapist. In a later phone call, the clinical supervisor alerted the team to the fact that the relationship between diagnoses and sub-diagnoses is not strictly such that one diagnosis contains many sub-diagnoses. Rather, sub-diagnoses can be members of many diagnosis classifications. This fact had a very large impact on the development of the database and the user interface of the database look-up tool.

Spine – Burlington interview and observation
The team interviewed and observed one call agent at the Spine – Burlington location. This call agent was a partial FTE with respect to handling patient calls, filling the rest of the work day with other clerical tasks and handling patient check-ins. During this visit, the team found that therapists may tend to treat patients of certain diagnoses, but call agents at other locations may not know about these tendencies. For instance, one Burlington therapist could not treat Medicare patients because a student was accompanying the therapist. If a call agent does not work at Burlington, scheduling appointments at Burlington would be difficult without knowledge of these kinds of details. Also, the call agent suggested adding to the database tool the ability to search by therapist availability. Even though call agents would not be able to book the appointment through the database tool, this feature would narrow the search results to only include the therapists that are most likely available during the patient’s desired time for an appointment.
Call agents could edit the color coding of therapist schedules (e.g. a “blue” appointment is a new patient evaluation appointment, a “green” appointment is for a returning patient, etc.) within the existing software system. Lastly, whether patients are new or revisit patients is an important distinction because of potentially differing default appointment lengths and restrictions regarding which therapists may treat them (i.e. physical therapy assistants (PTAs) may not treat new patients).

**C.S. Mott Children’s Hospital interview and observation**
The team interviewed one call agent at the PM&R location in the C.S. Mott Children’s Hospital. The location handles coordinated appointments, but the appointments are not always consecutive. Coordinated appointments are for patients who need treatment from providers of multiple disciplines (e.g. physical, occupational, and speech therapy). Having consecutive appointments is not typically a high priority because the Mott location only serves pediatric patients and some patients (and their parents) prefer to have breaks between appointments.

**MedRehab Briarwood Building 4 interview and observation**
The team simultaneously interviewed three employees at MedRehab Briarwood Building 4: two call agents and a therapist. During this group interview, the team found that this facility has unique equipment that other facilities do not. These pieces of equipment require call agents to schedule usage of the equipment along with certain patient appointments. The team also found that coordinated appointments are quite common at this location. One call agent’s remarks suggested that the database tool should include ability to search with multiple diagnoses.

During observation, the therapists recorded their patients’ availabilities to give to the call agents. If a virtual call center is implemented other call agents will not be able to assist in this process unless those notes become available to other facilities. The notes would have to be faxed to other facilities or scanned and shared with other call agents.

**University Hospital observation**
The team simultaneously observed three employees at the PM&R location in the University Hospital – each of these three employees were all partial FTE with respect to handling patient calls and filled the rest of their time with other clerical tasks and handling patient check-ins. In this observation, the team found that the call agents do not solely answer calls and schedule appointments. Rather, they have to perform other tasks while not handling one of those tasks. Some of these “other” tasks include handling patients checking in and out. Additionally, the team found that incoming calls can ring at one phone and then reroute to another phone after three rings. The peak hours in the day for incoming patient calls are around 7:45am and 12:45pm (due to the various therapist start times).

**MedRehab Briarwood Building 2 interview**
The team simultaneously interviewed three employees at MedRehab Briarwood Building 2 – a clerical manager, a former call agent, and a current call agent. During this interview, the team found the call agents need to distinguish between adult patients and pediatric patients because some therapists are not qualified to treat both types of patients. Also, the team found that some call agents can already schedule patients at the Mott location with ease. Lastly, the team found that default appointment lengths vary by location; one of the call agents suggested that the
database tool should include information about default appointment lengths at each location.

**Collected Call Log Data**
The Senior Clerical Supervisor has call log data broken down by half hour intervals from Rockwell reports. The Senior Clerical Supervisor gave samples of this data to build the read in and parse functions necessary for minimal modification done to the input files to the simulation model.

**Software Design and Implementation**

We created two pieces of software during this project. The first was a database tool to be used by call agents to assist them in finding appropriate therapists that may work in other location to treat a patient calling to schedule an appointment. The second was a simulation tool to be used by the Senior Clerical Supervisor in management decisions regarding call agent scheduling that shows the impact of these scheduling changes.

**Database Tool Design**

**Search Criteria**

- Diagnoses that each therapist can treat
- Therapist location
- Whether a patient is new or returning (revisit patient)
- Whether a patient is adult or pediatric
- Whether a patient is covered by Medicare
- Therapist (general) work schedule

To examine the possible therapist-time-location combinations for scheduling any kind of patient appointment, a call agent must know which diagnoses the potential therapist can treat, the potential therapist’s name, location, and general work schedule. However, the need for the remaining search criteria may not be as clear. A call agent using this database tool needs to enter whether a patient is new or returning because of restrictions that do not allow Physical Therapy Assistants (PTAs) to treat new patients. Additionally, call agents need to be able to input whether a patient is adult or pediatric because some therapists only have certification to treat one of those groups of patients and not both.

**Other Design Considerations**

The visits to the various locations within the PM&R Department also provided valuable information for design considerations for the database tool that do not directly relate to search criteria. For instance, the fact that each of the locations (and sometimes even each of the therapists) has widely variable scheduling procedures led to the realization that the database tool needs to allow for free-text “comments” sections that accompany each of the locations and therapists. In the implementation phase, whoever controls the data entry into the database is free to use these “comments” sections as they wish, but filling these “comments” sections with
information about the various nuances associated with scheduling for each particular location and therapist would be the best use of this functionality. Some examples of the information that a call agent might find in a “comments” section include default appointment lengths for a location, any temporary limitations in therapist ability to treat certain diagnoses due to their own injuries, and instructions on how to schedule coordinated appointments.

The majority of users of this database tool have little or no experience with Microsoft Access. Therefore, searching and editing the database in any way (adding therapists, editing therapists’ characteristics, etc.) should be as user-friendly as possible. Microsoft Access is not particularly user-friendly software, so the database tool should be able to handle all kinds of searches of and edits to the database with a very user-friendly and intuitive interface in which the user does not need to interact with Access. In making the interface of the database tool user-friendly, the team made several design considerations:

- Automatic loading of sub-diagnoses and locations
- “Comments” sections for therapists and locations
- Automatic population of therapist information in add/edit tab
- Password protection of add/edit functionality

Design criteria are described in the following pages.
Automatic loading of sub-diagnoses and locations

First, the levels of call agent knowledge regarding diagnoses and sub-diagnoses vary greatly. When a call agent needs to use the database tool to schedule a patient appointment at another location, he/she may know the patient’s specific sub-diagnosis or may only know the general diagnosis category for the patient. Thus, the database tool contains drop-down lists of general diagnosis categories and of sub-diagnoses. To aid the call agent in efficiently finding the desired sub-diagnosis, the list of sub-diagnoses is initially comprehensive across all diagnoses and updates to only include the specific sub-diagnoses for a certain diagnosis category when the user chooses a specific diagnosis category. For example, if there are two diagnosis categories (i.e. Amputee and Hand) and five sub-diagnoses for which Sub-Diagnoses 1-3 are in Diagnosis Category 1 (i.e. Leg, Arm, and Foot) and Sub-Diagnoses 4-5 are in Diagnosis Category 2 (i.e. Carpal Tunnel and Paralysis), then the database tool will hold the two diagnosis categories (Amputee and Hand) in the diagnosis drop-down list and the five sub-diagnoses in the sub-diagnosis drop-down list (Leg, Arm, Foot, Carpal Tunnel, and Paralysis) When the user selects Diagnosis Category 1, the sub-diagnosis drop-down list updates to only include Sub-Diagnoses 1-3. Additionally, selection of a diagnosis will automatically filter the list of locations that the user may search over. These design features are below in Figure 2.

Figure 2: a) Selecting the “Occupational Therapy” diagnosis automatically loads all related sub-diagnoses. b) Selecting the “Men’s Health” diagnosis automatically filters the list of locations to just Canton and University Hospital.
“Comments” sections for therapists and locations
Related to the presumed lack of user experience with Microsoft Access, the team made the “comments” texts for each therapist and location readily accessible. Specifically, when the user searches the database and generates a resulting list of therapist records, the user can access the “comments” section for a therapist or location by double-clicking on the cells that contain the therapist names and location names in the list of therapist records. These “comments” sections appear in a separate window to avoid cluttering the main interface. This feature is shown on the next page in Figure 3.

Figure 3: a) Double-clicking on a therapist’s name in the search results brings up a new window with free-text comments about that therapist. b) Double-clicking on a location name in the search results brings up a new window with free-text comments about that location.
Automatic population of therapist information in add/edit tab
Similarly, the team has designed the interface of the database tool such that, in the add/edit tab, choosing a therapist from the drop-down list of therapists automatically populates all of the controls within the interface with the therapist’s current characteristics. These controls include the various check boxes, numeric up-downs, and radio buttons that tell the therapist’s location, the therapist’s ability to treat new patients, and the therapist’s ability to treat adult and/or pediatric patients. Additionally, the drop-down lists for diagnoses automatically updates to only include the diagnoses that the therapist treats.

In this way, the user immediately sees all of the most relevant current information and can quickly make the most likely edits – adding or removing sub-diagnoses from the therapist’s list of sub-diagnoses treated, updating a therapist’s ability to treat new patients, etc. This design feature is shown on the next page in Figure 4.

Figure 4: Selection of therapist “Joey” in the “Add/Edit Therapist” tab automatically populates all of the controls on the form with Joey’s attributes
Password protection of add/edit functionality
Since the database tool will be stored on the department clerical staff’s shared drive, anyone with access to the drive will be able to use the software. This implementation has both advantages and disadvantages. The advantage is that all call agents will be able to use the database tool and therefore have the information needed to schedule patient appointments at all PM&R locations. However, if all call agents are able to use the database tool, they also may edit the database in ways that are inaccurate and/or unwarranted.

With this fact in mind, the team added password protection to the add/edit tab of the interface so that only the client and those with whom the client shares the password can add and edit entries in the database. This design feature is shown on the next page in Figure 5.

![Password Protection Interface](image)

Figure 5: Navigating to the Add/Edit tab of the database tool forces the user to enter the password in order to add or edit any entries in the database.

Database Tool Implementation

The team originally planned to implement the database tool by the conclusion of the project, but many of the implementation tasks have been left to PM&R personnel. Specifically, the actual information about therapists, diagnoses, sub-diagnoses, and locations have not yet been entered into the database. Instead, the responsibility of entry of this information has been left to the Senior Clerical Supervisor and the PM&R Department. Their expertise and first-hand knowledge about the information that the database tool requires will ensure that the information in the database is fully descriptive and accurate. However, the team has entered some “dummy” entries into the database solely to test the integrity of the functionalities of the database tool. For example, one “dummy entry” might have a therapist name of “Therapist 1,” a therapist location of “Location 1,” etc., instead of actual names and actual PM&R locations.
Simulation Tool Design

To justify the time and expense of implementing a centralized virtual call center design, the Senior Clerical Supervisor wanted the team to quantitatively show the decrease of patient call wait times from this new call center design. In addition, the Senior Clerical Supervisor believes that it is possible to reallocate FTEs from call agents to other tasks while keeping these patient call wait times low. To display the impact of staffing changes in a centralized virtual call center design, the team decided to build a simulation model that would simulate calls arriving based on historic data. Given a call agent work schedule, the tool simulates call agents answering incoming calls to find average patient call wait times throughout the day.

Overview

The model takes as input historic data about frequency and length of incoming calls, and additional work generated from these calls. These frequencies are broken into half hour periods every day, and are presented in PDF format by Rockwell. We read text versions of these into input and parse out the aforementioned crucial pieces of information necessary for the simulation. The model also reads in information about the call agent themselves, including start time, end time, FTE level (in percentage, 100 being full-time call agent, 0 being not a call agent at all), and their priority, to be described below in more detail. From these two inputs the simulation has all the data necessary to run.

The simulation runs by first determining a probability that a call comes in any five-second interval. Then the simulation determines whether a call comes in that 5 second interval based on that probability. As soon as a call comes in it is put into a queue of calls. Then the simulation searches through therapists, and determines if any are finishing their current tasks, therefore able to handle a new task, or if they are still busy. Then if there are calls in the queue, the calls are assigned to call agents as feasible. The simulation keeps track of how many callers are in the queue to determine wait time as described by Little’s Law which states that the sum of wait time is the integral of the number of people waiting described over time.

Once the simulation has completed, it outputs the average wait time by half-hour interval. This is output in the form of a CSV file for easy conversion into tables and graphs that the Senior Clerical Supervisor can use for reports to management.

Modeling Decisions

FTE Levels

There are many elements which make this system unique from other similar systems. One of the big elements that had to be handled was the system in which partial FTEs are handled. A partial FTE has two jobs they spend some portion of their time on, yet while working as a call agent they are just as efficient as any other call agent.
**Priority**
Among partial FTEs there are differences in how conflicts are handled when two tasks coincide. Some partial FTE call agents will prioritize their other tasks, handling them rather than incoming calls, only going to incoming calls when they are sitting idle. Other FTEs will prioritize their call agent tasks and will only perform other tasks when they are necessary. We deem the former as non-priority call agents and the latter as priority call agents. In terms of the modeling, we generate tasks randomly that non-priorities complete, and will not answer calls while performing these tasks. Priority partial FTE call agents will answer calls until they have used the portion of time allocated for their call agent duties, and then will not answer any more calls.

**Data Aggregation**
The Senior Clerical Supervisor may want to see the simulation model run on only Mondays when call volume is highest, or maybe only during summer, which may potentially be a peak season. The model will take any data offered and simulate based off of that data, so these two goals can be achieved by only using data from Mondays or only using data from summer months respectively. This data aggregation ability grants more power to the Senior Clerical Supervisor to reallocate hours throughout the week and see the impact of those changes.

**Simulation Tool Implementation**
The team recommends the Senior Clerical Supervisor keep this to themself, or distribute very selectively as fitting. This simulation tool has no application to the job of a call agent individually, and is only useful for management purposes in determining which schedule is best for the system as a whole. The simulation tool can be run on any Windows computer.

**Recommendations**
Before use by the call agents, the information in the database must be verified by each of the following: the Senior Clerical Supervisor, the call agents in each location, and the therapists in each location. This verification will ensure that all information entered about the therapists, locations, and the specific scheduling practices for each therapist and location is fully detailed and accurate. After this verification, the team recommends that the Senior Clerical Supervisor places the database tool on the share drive to be accessed by all call agents in the six locations. We have implemented password protection for modifying this data and this password will be provided to the Senior Clerical Supervisor to distribute as needed. This database tool is only guaranteed to run on a Windows PC.

The team recommends that the simulation tool is only loaded onto the Senior Clerical Supervisor’s computer since very few people need to use it. Additionally, the results of the simulations could suggest staffing changes that may be unpopular to staff members if they know of the potential changes to be made. This simulation tool is only guaranteed to run on a Windows PC.
Impact

The database tool will enable the call agents in any of the six aforementioned locations (Briarwood 2, Briarwood 4, Burlington, Canton, Mott, and University Hospital) to schedule patient appointments in any of the other locations. This change from the current state will allow the phones at all locations to be linked into a virtual call center design and will then reduce the time patients wait on the phone to be scheduled for an appointment, as they will be able to immediately talk to a call agent and will not have their call transferred to another location. This reduction in wait time leads to increased patient satisfaction with the call and scheduling processes, while ultimately increases the department’s revenue.

The simulation tool will allow the Senior Clerical Supervisor to see the impact of shifting call agent schedules, hiring new call agents, or reallocating call agent FTEs with respect to the average patient wait time to talk to a call agent. This increased visibility will allow the Senior Clerical Supervisor to allocate and use employees more efficiently.
Appendix A – Diagram of Project Goals & Tasks