University of Michigan Health System
Program and Operations Analysis

Analysis of Room Allocation in the Taubman Center Clinic of Internal Medicine

Final Report

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Executive Summary

The Internal Medicine Department at the University of Michigan Health System, located on the third floor of the Taubman Center, is concerned that there is not enough exam space for the rising patient demand. Physicians have complained that they are not allocated enough exam rooms to see their patients in the most efficient way. This project was done to evaluate and analyze the current room allocation process and to create a new room allocation process that allows the department to optimize operations. Department changes are expected to take place July 1, 2005.

The clinics are separated into four Pods (A, B, C, and D). Each Pod has its own registration and discharge area, and its own waiting room. This project focuses only on Pods A, C, and D, as appointments in Pod B are scheduled by Ambulatory Care. Therefore Pod B is not within the scope of this project.

This project is a continuation of a project that began during the fall of 2004. The main difference between this project and the previous project is that this project uses more recent data (July-December 2004). The previous project used data from the fiscal year 2004 which included physicians that no longer practice in the Internal Medicine Department and the data allocated rooms to resources that were untraceable. The previous project also included recommendations made by the previous student team and clinic management.

The student team analyzed previously recommended models as well as ideas from clinic management to verify that their models were valid. The team also considered two types of models for room allocation using the current data and the goals and objectives identified by the management of the Internal Medicine Department. The goals and objectives included: determining clinics that are suitable to move to other pods or offsite locations, and keeping clinics in their entirety in one Pod such as moving Rheumatology to Pod A.

By keeping the goals of the department in mind, the student team began the project. The project was completed in six phases:

- Observation- The team met with department leaders to discuss current problems, and performed a visual analysis of patient flow in Internal Medicine subspecialty clinics.
- Data Collection- Data was provided to the student team by the client. The data included:
  - January Allocation Sheet (JAS) and Schedule from Enterprise Wide Scheduling (EWS) in Excel Format
  - An EWS sample size greater than 90,000 entries
  - EWS data from July-December 2004
  - EWS included:
    - Scheduled Appointment Time
    - Physician
    - Clinic
    - Appointment Status (Arrived, No Show, Cancelled, Rescheduled)
    - Procedure
• Data Analysis- The data was sorted and compiled in Excel. The student team considered both the JAS, and EWS. The data was sorted by clinic, instead of by Pod as before to keep in line with one of the goals of the project, which was to keep the clinics in their entirety in one Pod. The team then removed patients that had a status of Cancelled (C) or Rescheduled (R) from the data to account for only expected patients. The data was then analyzed statistically to identify the days and times when exam rooms are being underutilized. The team found the average number of expected patients to be seen each day by each physician during each half day period according to the EWS data. Next, the team created tables to compare the JAS and the EWS data. These tables included the average number of patients plus 10% to account for variation. The tables were then used to create new models for room allocation.

• Modeling- The team considered two types of models: the “shared” model, and the current scheduling model using new assumptions and rules.

• Creating Recommendations- After the modeling phase, the team made some recommendations for the department.

Two types of models were considered in this experiment. The first was the “shared” model. The idea of the shared model was to assign three physicians a total of five rooms that would be “shared” between them. The assumptions used when attempting to create this model were: each appointment was 30 minutes (accounts for 15 minute return visits and 45 minute new patient visits) therefore, during a half day period, 8 patients can be seen in each room. The team looked for any 3 physicians that saw about 40 patients together. There were no three physicians that saw about 40 patients, so this model was disregarded.

The other type of model examines the current room allocation model and changes the number of rooms allocated based on the actual averages calculated from the data. For example if a physician says that he/she sees and average of 12 patients during the Tuesday morning clinic and needs two rooms, but actually sees an average of 7 patients during the Tuesday morning clinic, the model allows that physician to be allocated only one room thus freeing up 1 room. To develop this type of model, the team identified new rules and assumptions to be used. The new rules and assumptions are:

• Use actual data
• Account for variation in average patients seen
• Change assumptions to create various models

When creating this type of model, the team also had to consider the constraints provided by the client. The constraints were:

• Medical Genetics and Rheumatology are assigned 7 rooms in Pod A
• Allergy, Nephrology, Pulmonary, and Cardiology are assigned 22 rooms in Pod C
• Gastroenterology (14 rooms), Infectious Diseases, and MEND (Metabolism, Endocrinology & Diabetes) are assigned 23 rooms in Pod D
• Clinics in Pod C are not conducive to smoothing

1 Smoothing means taking the total number of actual rooms used per clinic based on our calculations and dividing them over 10 half day periods evenly.
The team created five models of this type using different assumptions and rules for allocation for each of the models. The five models the team created are (Models can be found in Appendix B):

- **Model A**: No smoothing; Gastroenterology is allocated 14 rooms as requested.
- **Model B**: No smoothing; Gastroenterology is not allocated 14 rooms (allocated the number of rooms needed according to EWS data).
- **Model C**: Smoothed the clinics that are willing; Gastroenterology is not allocated 14 rooms (allocated the number of rooms needed according to EWS data).
- **Model D**: Smoothed the clinics that are willing; Gastroenterology is allocated 14 rooms as requested.
- **Model E**: Smoothed the clinics that are willing; Gastroenterology is not allocated 14 rooms (allocated number of rooms needed according to EWS data); Allergy is moved to an offsite location.

After reviewing the models, the student team recommends that:

- Allergy move to an offsite location.
- If Allergy is unwilling move, smooth clinics in Pod C (Cardiology, Allergy, Nephrology, Pulmonary). This would alleviate the overcrowding in Pod C.
- The department consults EWS data when physicians request more rooms.
- The department uses our models as a template for future modifications of room allocation.
Introduction

The third floor of the Taubman Medical Center services several divisions of the Department of Internal Medicine. Currently, the clinic is operating essentially at capacity and is expecting an increase in patients. The clinic is facing problems with its current room allocation model. Therefore, the purpose of this project was to examine and analyze the current scheduling process, the operations and procedures, the space requirements of the clinic, and to create a room allocation model that will maximize room utilization in the Internal Medicine Clinic on the third floor of the Taubman Center.

To maximize room utilization, it was necessary to analyze the current room allocation process using existing data and visual observations of the clinic. This report includes a new patient allocation model, some implementation ideas and a management tool to assist clinic managers and their director with future maintenance of the new model. The recommendations included in this project are intended to be implemented within the department as of July 1, 2005.

Goals and Objectives

To optimize exam room utilization, the following were goals for the project:

• Evaluate current and previously recommended room allocation models
• Analyze the exam room utilization of all Pods of the Internal Medicine Clinic
• Determine possible clinics that are suitable to move to other Pods
• Identify possible clinics that are suitable to move off site
• Create a new room allocation model that optimizes exam room utilization

Background

For the purpose of this project, the following definitions were established by the client and the student team:

Department: The Internal Medicine Clinic of the Taubman Center in its entirety.

Pod: A section of the clinic that has its own registration discharge areas as well as its own waiting room on the third floor. The third floor of the Taubman Center is divided into four pods. Internal Medicine subspecialty clinics operate in three of these pods: A, C and D. Pod B is independent from the other three pods and is run by Ambulatory Care; therefore, it was not considered in this study.

Clinic: A division within the Internal Medicine Department. Ten clinics were analyzed in this study: Cardiology, Gastroenterology, Allergy, Medical Genetics, Infectious Diseases, Pulmonary, Rheumatology, Nephrology and MEND. In this report clinic will also be used as the time in which patients are seen. The Internal Medicine Clinics divides each day into two clinics (AM and PM). The morning clinics begin at 8:00AM and ends at 12:00PM and the afternoon clinics begin at 1:00PM and ends at 5:00 PM.
The Internal Medicine subspecialty clinics realized the inefficiency of its current room allocation model, which is used to assign exam rooms to physicians in pods A, C and D. The realization led to the need for a student team to perform this project. This project was a continuation of one that began during the fall semester of 2004. The previous project was very similar to this one in that it examined and analyzed the way in which rooms are allocated in the Internal Medicine Taubman clinics and then created potential new room allocation models that would optimize the efficiency of the clinic. However, the data was outdated, so for this project, the student team examined more recent data. The intent of this project was to optimize the occupancy of the rooms and to make the clinic more efficient. The student team verified the models and methodology of the previous project to create new room allocation models.

The inadequacy of the current room allocation model is evident when exam rooms are used for a small period during the day and then are empty for the rest of that half-day period (am or pm). The current room allocation process assigns a certain number of rooms to a single physician for the first or second half of the day solely based on the number of patients scheduled per physician. When the number of patients scheduled is between one and seven, one room is assigned for that physician. If there are more than eight patients scheduled, two rooms are assigned. When a room is assigned to a physician, it is assigned for the entire half-day period.

A few possible solutions were suggested either by management of the clinic or by the previous student team that may improve the current situation. The student team analyzed these solutions and created five new possible solutions.

**Key Issues**

Three key issues led to the need for this project:

- Exam rooms are not being utilized optimally
- The throughput of the Taubman Clinics does not meet rising demand
- The waiting time for patients is excessive in the waiting rooms as well as in the exam rooms, leading to patient dissatisfaction

**Scope**

This project made use of modeling to create a new room allocation process for the ten clinics of the Internal Medicine subspecialty clinics that operate in the Taubman Center. The project focused on Pods A, C, and D, as Pod B is scheduled for use by Ambulatory Care and was not considered in this project.

This project did not take into account any of the offsite clinics when producing models; however, it did consider which of the clinics may be best suited to move off site or to other pods.

This report includes a recommended model for room allocation along with some possible implementation methods and a tool for maintenance of the model. It does not include solutions to operational issues. Similar to the previous project, flow rates of patients, patient wait times in the waiting room and exam rooms, queuing, and patient to physician interaction times were also excluded from this study.
Methodology

Approach

As the second phase of a previous team’s project, the approach was very similar to that of the last group. The basic steps to this project were: observation, data collection, data analysis, modeling and recommendations.

Observed Department

The observation phase consisted of an initial meeting with division leaders to discuss current clinic problems and possible resolutions to the existing room allocation model. The second part of the observation phase included a visual analysis of the patient flow in the Internal Medicine subspecialty clinics. The student team observed the way in which patients are checked in, taken to an exam room, seen in the exam room, and checked out after their appointments.

Collected Data

The client provided the student team with current data as a Microsoft Excel file as well as the January Allocation Sheet (JAS). The JAS is the template that the department is currently using to allocate exam rooms to physicians. The JAS included the physician, the number of patients that they report seeing per each half day period, and the number of rooms allocated to each physician. The JAS was separated by Pod.

The current data included the patient schedule between July and December 2004: the scheduled appointment time, the physician, the clinic, the scheduled appointment time, the appointment status (arrived, canceled, no show, rescheduled) and the procedure. The sample size of the data was greater than 90,000 entries. The student team used Excel to sort and compile the data for analysis by removing any entries where the patient either cancelled their appointment or did not show up because it was important to only account for patients that were expected to be seen in the clinic each day. The student team also removed any outliers. If a physician saw less than two patients during a clinic, that clinic was removed from the data.

Analyzed Data

Data analysis was the next phase of the project. This phase included a statistical analysis of the provided data to find the days and times that each of the nine divisions either needs more rooms or has excess rooms. To perform the statistical analysis, the student team first sorted the EWS data by clinic instead of by Pod (as in JAS) so that all subspecialties were separated. Then the student team calculated the average number of patients that each physician saw during each half day period from EWS and compared the values to the number of patients that the physicians reported seeing each day from JAS. Physicians that were not present in the JAS, but were present in EWS were included in our calculations. The calculated averages included decimal values. For the purposes of this project, the student team rounded a value of 7 up or down based on the decimal value. Only a value of 7 needed to be rounded since 8 is the minimum number of patients a physician must see in order to be allocated a second exam room for a certain half day period. If EWS was lacking data for certain physicians, we assumed that the JAS was correct. For example, for some physicians, the number of patients that they report seeing during a half
day period was missing. Therefore, the student team used the same number of rooms allocated to that physician in the JAS.

By comparing the actual average number of patients seen to the reported number of patients seen, the student team was able to verify that the number of rooms assigned to each physician during the day were necessary.

**Created Models**

After the statistical data analysis was complete, the modeling phase began. First the student team considered a three-physician-to-five-room ratio and compared it to the current one-physician-to-many-room ratio. This model was one that was recommended by the previous student team.

The other consideration was to keep the current room allocation model of assigning rooms based on the number of patients seen, but to use the data with the calculated averages instead of the physician reported averages. The team created five new models for room allocation using different assumptions for each model to provide to the client.

**Created Recommendations**

After the client chose a model, the student team provided additional recommendations. The recommendations include some thoughts regarding the implementation of the new room allocation model.

**Findings**

Using the data analysis, the student team identified the cause for the underutilization of exam rooms. The cause was that current allocations of exam rooms do not meet actual needs. Many physicians request many more exam rooms than they actually need, causing the rooms to be unused for much of the day. Please see Appendix A to find the actual needs of each clinic.

**Considered Alternatives**

**Shared Model**

The team considered two types of models for room allocation. The first was the “shared” model which was recommended by the previous student team. The idea of the shared model was to assign three physicians a total of five rooms to share between them. The student team created assumptions before developing an actual model.

The assumptions were:

- Each appointment is 30 minutes long. This accounts for 15 minute return visits as well as 45 minute new patient visits.
- During a half day period, 8 patients can be seen in each exam room.

Based on our assumptions, we were looking for three physicians that together saw a total of about 40 patients during any given half day period, and the model would then be created to allow these three physicians to “share” five rooms. Based on the EWS data, the reality is that no three
physicians together see 40 patients in a half day period. So, this model was eliminated from the considered alternatives as it will not work using the assumptions identified above.

**Current Model with New Assumptions and Rules**

The client expressed that the current assumptions and assignment rules are not working, so for the next models, the team used the current room allocation model as a basis, and changed the assignment rules and assumptions to create five new models. The new rules and assumptions are:

- Use actual data
- Account for variation in average patients seen
- Change assumptions to create various models

To account for variation, the team included 110% of the average number of patients seen.

The client also provided constraints to follow when creating these models. The constraints were:

- Medical Genetics and Rheumatology are assigned 7 rooms in Pod A
- Allergy, Nephrology, Pulmonary, and Cardiology are assigned 22 rooms in Pod C
- Gastroenterology (14 rooms), Infectious Diseases, and MEND (Metabolism, Endocrinology & Diabetes) are assigned 23 rooms in Pod D
- Clinics in Pod C are not conducive to smoothing

The five models the team created were (see Appendix B):

- **Model A:** No smoothing, Gastroenterology is allocated 14 rooms as requested.
  - Conclusions:
    - The number of rooms needed exceeds the number of rooms allocated.
      - 7 rooms are not enough for Pod A during the following half day periods: Monday AM, Monday PM, and Thursday AM.
      - 21 rooms are not enough for Pod C during the following half day periods: Monday AM, Monday PM, Wednesday AM, Thursday PM, Friday AM, and Friday PM.
      - 23 rooms are not enough for Pod D during the following periods: Monday PM, Tuesday PM, Wednesday PM, Thursday AM, and Thursday PM.
    - The department capacity of 51 rooms is exceeded on two different half-day periods.

- **Model B:** No smoothing, Gastroenterology is not allocated 14 rooms (allocated the number of rooms needed according to EWS data)

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*Smoothing means taking the total number of actual rooms used per clinic based on our calculations and dividing them over 10 half day periods evenly.*
Conclusions:
  o On certain days, the number of rooms needed exceeds the number of rooms allocated.
    ▪ 7 rooms are not enough for Pod A during the Thursday AM period.
    ▪ 21 rooms are not enough for Pod C during the following half day periods: Monday AM, Monday PM, Wednesday AM, Thursday PM, Friday AM, and Friday PM.
    ▪ 23 rooms are not enough for Pod D during the following half day periods: Monday PM, Tuesday PM, Wednesday PM, Thursday AM, and Thursday PM.
  o The department capacity of 51 rooms is not exceeded on any day.

- Model C: Smoothed the clinics that are willing, Gastroenterology is not allocated 14 rooms (allocated the number of rooms needed according to EWS data).

Conclusions:
  o On certain days, the number of rooms needed exceeds the number of rooms allocated.
    ▪ 7 rooms are not enough for Pod A during the Thursday AM period.
    ▪ 21 rooms are not enough for Pod C during the following periods: Monday AM, Monday PM, Wednesday AM, Thursday PM, Friday AM, and Friday PM.
    ▪ 23 rooms are not enough for Pod D during the following periods: Monday PM, Tuesday PM, Wednesday PM, Thursday AM, and Thursday PM.
  o The department capacity of 51 rooms is not exceeded on any day.

- Model D: Smoothed the clinics that are willing; Gastroenterology is allocated 14 rooms as requested.

Conclusions:
  o The Monday AM period and the Friday PM period exceed the 51 room department capacity.
  o The number of rooms needed does not exceed the number of rooms allocated for Pods A (7) and D (23).
  o The number of rooms needed exceeds the number of rooms allocated for Pod C (21).
  o The number of rooms allocated to Allergy (27) is less than the number that they actually need (30).

- Model E: Smoothed the clinics that are willing, Gastroenterology is not allocated 14 rooms (allocated the number of rooms needed according to EWS data); Allergy is moved to an offsite location.
Conclusions:
  o The number of rooms needed for Pods A, C, and D are less than the number of rooms allocated.
  o The department capacity of 51 rooms is not exceeded on any day.

Recommendations

After creating the five new models, the student team recommends that Allergy should be moved to an offsite location. If Allergy is unable to move, smooth the clinics in Pod C to alleviate the overcrowding on certain days. The team also recommends that the department consult the EWS data when physicians request an increase in the number of rooms that they are allocated. Lastly, the department should use the models created by the student team as templates for future modifications to the room allocation process.