University of Michigan Health System
Program and Operations Analysis

Analysis and Modeling of the Third Floor Taubman Center Clinic
Final Report

To: Cherie Freed, Administrative Associate Internal Medicine Clinic Operations
Virginia Walter, RN-Director Patient Care Services
Lindsay Graham, Chief Admin. Officer-Internal Medicine

From: JOE 481 Project Team, Programs and Operations Analysis
Jordan Funk
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Date: December 14, 2004
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Executive Summary

The third floor Internal Medicine Department of the Taubman Medical Center of the University of Michigan Hospital in Ann Arbor, Michigan was concerned that extra exam space was necessary to meet the demand of patients each day. The Department houses 10 clinics in 3 Pods (A, C and D) on the third floor. Several alternatives were presented by the Internal Medicine Department, including reassigning physicians to different days or times and moving one or more clinics to an off site location. The research and analysis team assigned to this project reviewed patient and physician data from the 2004 fiscal year as well as current scheduling data for the month of November, 2004 in order to assess the efficiency with which exam rooms were being assigned and utilized.

Analysis of current scheduling protocol was addressed in 5 steps. First, the team completed general observation of each of the three involved pods. These observations included visual inspection of reception areas, room usage, and interviews with Medical Assistants in each of the pods over the course of two weeks in September, 2004. Second, data was collected from various sources. The internal medicine department provided the analysis team with patient data from 2003 and 2004. This data was stratified by physician, clinic, and day. Interviews with Clinic Leads and Medical Assistants were also conducted to collect additional data. After all data was collected, the third phase, analysis, began. During the analysis phase, information regarding average room usage, patients per day, and scheduling limitations were discovered. This transitioned into the fourth phase, modeling. Using the conclusions from the analysis phase, three distinct models were generated. The first model assigned rooms based on the average number of patients per physician from the provided data. The second model assigned rooms based on a sharing model, splitting rooms between two physicians of a single clinic. The final model explored the impacts of assigning rooms one day in advance based on actual patient numbers. Finally, during the recommendations phase of this project, the models were compared to the status quo and presented to the Internal Medicine Department. Room savings in each model were also calculated.

Based upon the findings from the three models, it was concluded that implementing the shared model scheduling system would generate the most room savings. By assigning doctors fractional rooms based on the number of patients they see in a half-day session, single use rooms are eliminated and several rooms are emptied and made available. It was found that by using the shared model, additional room space was unnecessary as was moving one or more clinics off site. It was also found that physicians and clinics would not have to change their current days or times, which would minimize inconvenience to the clinics themselves.

Benefits of implementing the shared model include:

- Reducing the number of rooms needed by the department each day by 14 per half day session on average
- Centralizing clinics in one pod for an entire week, and allowing clinics to follow themselves through the morning to afternoon changeover
- Locating rooms for a given physician close to each other to eliminate walk times
for convenience

- Keeping Medical Assistants in charge of the same clinics each half day will reduce the amount of stress and changing workload demands
- Assigning flex-rooms to accommodate for add-on patients without having to spread the clinic out over multiple pods

As with any model, the shared model has disadvantages. The drawbacks to the shared model include:

- Personality conflict with the model – Physicians will not want to share rooms with other physicians as it eliminated the notion of having dedicated private rooms each day

The current model sought to provide an accurate picture of average patient volume by physician, clinic, and time period, and processing this data through the current scheduling discipline (7 or less patients equates to one room per physician). Some benefits of the current assignment model include:

- Assigning rooms based on simple “over/under” rule: allows for faster, more straightforward creation of each schedule
- Allowing each physician to maintain privacy and exclusivity by not sharing rooms with other doctors

However, drawbacks of the current assignment model include:

- Assigning entire room for doctors who see only a few patients a day, which increases the amount of time a room stays empty, and increases wait times as a result
- Moving clinics to different pods over the course of the week due to larger room allocation for each clinic, causing possible stress and confusion
- Splitting clinics between different pods due to spatial conflicts, thus decentralizing the clinic’s resources and creating inconvenience and inefficiency for both employees and patients
- Allocating “flex” or extra rooms in addition will create greater demand for clinic space, which cannot be met in every instance, or can only be met by moving clinics or splitting clinics between pods

The final model presented in this report is a daily scheduling model. The daily scheduling model attempts to develop a schedule based upon patient load for a given period. This is done by evaluating average patient load for a particular period and determining how this load can be distributed uniformly across all available room resources, which results in a patient per room policy. This policy is then implemented in the same way that the current 7 patients per room policy is implemented. Benefits of the daily assignment model include:

- More efficient at adjusting to fluctuating patient loads
- The use of policies for this model is similar to current practice. Therefore, this would have a minimal impact on usual daily activities of staff.
- Uses real-time patient data for the basis of room assignments rather than monthly
anecdotal determinations of the number of patients that will be seen by each doctor.

Drawbacks of this model include:

- Requires a significant increase in the amount of work put into room scheduling, which is simply a result of scheduling daily rather than monthly.
- The daily scheduling model presented in this report is limited to evenly distributing patient loads across all available rooms and does not necessarily result in the most efficient room schedule.

Finally, the analysis team strongly recommends further study be done to verify the data and records kept by the Internal Medicine Department. The data provided by the Internal Medicine department neglected to include information regarding some physicians, and included physicians who no longer worked in the department. It also allocated rooms to resources that were untraceable, and this usage was not accounted for in analysis. Implementing any of these models would be simple. We recommend using the shared room model in order to benefit from maximum room savings. An appropriate action plan to implement this model would be to begin with education about the new room assignment policy. Since a change to this type of room scheduling will require a significant change in thinking about room usage, we do not recommend the new policy be implemented without some education and training period. Some key issues that must be expressed during the education/training period would be the gross inefficiency of dedicated room assignment and the extraordinary benefit of shared rooms. Once the Internal Medicine Department staff is made to feel comfortable with the change, then the monthly template can be developed and implemented. It is entirely possible that implementation of the new policy be gradual with stages until the entire Internal Medicine Department is utilizing the new room assignment policy. Another possibility is to implement the new policy in a particular area of the Department and observe its effectiveness through a trial period. Based upon the results of either a gradual implementation or trial period, then monthly templates can be developed for full implementation in July 2005.
Introduction and Background

For the purpose of this study, both the client and the research team utilized the following terminology:

*Department:* The umbrella organization encompassing various clinics. This study was concerned with only the Internal Medicine department.

*Pod:* Defined by one of the four reception areas located on the third floor of the Taubman Center. Pods A, C, and D all belong to the Internal Medicine department and were included in this study. Pod B is an independent department and was therefore excluded from analysis. Each Pod houses between one and four clinics, depending on the day and shift (morning or afternoon).

*Clinic:* The individual parts of the Internal Medicine department. The ten clinics located in Pods A, C, and D were analyzed.

The University of Michigan Health Care system includes several inpatient care locations. One of the inpatient centers located within the main hospital in Ann Arbor, Michigan is the Taubman Medical Center. The third floor of the Taubman Center sees on average over 70,000 patients annually, and rising patient demand presents an increasing need to service these patients in a timely manner. However, the third floor of the Taubman Center is already filled to capacity with clinics, fellows and staff varying from General Internal Medicine to Cardiology. Therefore, the third floor faces the common problem of having more need for exam rooms than available space permits. The Gastroenterology clinic will be moving to “Pod” D in July 2005, who will schedule all of their rooms each half day (10 half day sessions per week), which will make more exam space available, but this move alone will not alleviate the patient backups. With this move, other clinics will need to shift to open up the space, and a re-examination of status quo room assignments will be required to determine if the current setup is the best utilization of space. Therefore, the purpose of this project was to conduct a series of studies on the various clinics, fellows and staff, including their operations, procedures and the space requirements of the Internal Medicine department. After conducting these studies, three different models were created utilizing patient data provided by the Internal Medicine department for redistributing the available clinic space. The three models developed are a room-sharing model, redistribution of current assignments without disruption of current day/time model, and the optimal distribution model based on clinic constraints. This report presents the methodology in completing this study, a view of the current situation, the alternatives considered, and finally the findings and recommendations based upon the research. Through the action plan presented in this report, the third floor Taubman center will be able to better allocate clinics and physicians to make more clinic space available.

The third floor houses clinic space used by General Internal Medicine, Cardiology, Gastroenterology, Allergy, Medical Genetic, Infectious Disease, Pulmonary, Rheumatology and Metabolism, Endocrine and Diabetes (or MEND) clinics. Each of the
Pods is largely self-contained, each with its own office, staff space, check-in and checkout areas, and patient waiting areas. The scheduling for each day, and each room is completed on a monthly basis. Currently, delays and other logistical problems arise when patients seeing physicians in different clinics are scheduled after each other in the same Pod. The changeover from morning to afternoon clinics is a commonly identified problem by clinic staff.

**Key Issues**
Throughout this project, the original key issues continued to evolve and new issues emerged. At the end of analysis and modeling, the following key issues existed:
- The GI department (including GI-Liver) will be permanently moving to “Pod” D and occupying 10 half-day sessions per week
- Exam rooms are not being fully utilized and many rooms remain empty during the day
- Conflicts and delays associated with the morning to afternoon clinic changeover
- Room assignments are inflexible leading to poor communication and utilization

**Scope**
The scope of this project can be described in levels. On the most general level, only the Internal Medicine Department, located on the third floor of the Taubman Medical Center (The University of Michigan Hospital, Ann Arbor) was analyzed. Of the four existing Pods on the third floor, only clinics located within Pods A, C, and D were included in the project scope. Pod B is dedicated to general Internal Medicine, and was not included in our project scope. The clinics involved in this study included:
- Allergy
- Cardiology
- Endocrine (including Metabolism and Diabetes)
- Infectious Diseases
- Gastroenterology (including GI-Liver)
- Medical Genetics
- Nephrology
- Pulmonary
- Rheumatology

**Goals and Objectives**
The following goals and objectives were associated with this project:
- Creating several models that will accurately depict the utilization
- Determining the clinics, fellows or staff that can be moved to alternative locations within the third floor
- Providing recommendations of the most appropriate clinics, fellows or staff to be moved to alternative locations within the floor
- Increasing the space available on the third floor of the Taubman Center through these recommendations
Approach and Methodology

To determine the best method for allocating exam room space on the third floor of the Taubman Medical Center, data from Fiscal Year 2003 (provided by the department of Internal Medicine Operations) was analyzed. In particular, we investigated data by the various divisions by time (morning versus afternoon) and location (Pod A, C, or D). On a more specific level, we were concerned only with the number of patients scheduled to each doctor each day, and analyzed this information by clinic and time of day. Issues concerning variances with the number of patients per doctor per time period were also examined on a limited basis.

This project did not examine activity not directly related to the space allocation and utilization of Pods A, C, or D. Specifically, Pod B is managed by general medicine, and was not considered. Also excluded from this study were flow rates of patients, queuing, wait times, patient-physician interaction times, specific procedure or exam type analysis (including joint injections, teachings, etc.), or further breakdown of data beyond what is described above. Analyzing these additional factors would have expanded the scope of this project beyond what could feasibly be completed in the 15-week time span. As extensive data and findings regarding these exclusions do not exist, further study in these areas would prove to be beneficial.

Project Phases

This project was completed in five phases: observation, data collection, data analysis, modeling, and recommendations. Each of the three Pods included in this study was observed (in one hour blocks), both in the morning and afternoon shifts, over the course of 10 working days (2 weeks). Observation was limited to visual analysis of general patient flow (exact timings and volumes were not considered) as well as interviews with both receptionists and Medical Assistants assigned to each Pod. These observations were compiled and used in conjunction with the data, which was provided by the client.

During the data collection phase, data (in Microsoft Excel format) was obtained from the client. Significant findings and information gathered from observations were combined with interviews from medical clinic Medical Assistants. Any missing data points in the provided data files were individually collected from the client. The final step in the data collection phase was to organize and condense all of the available data into a one single file, which could be easily analyzed by the team. The Clinic Leads, which are the physicians in charge of the different clinics, were interviewed to determine the needs and constraints of each clinic (a detailed list of the interview questionnaire can be found in Appendix A).

Once all of the data had been collected, the analysis phase began. Constraints identified from interviews with the Medical Assistants from each of the clinics were applied to the data set and the data was adjusted in order to uphold these limitations. Average patient flows (patients per doctor/day, clinic/day, etc.) were calculated. Analyzing the data collected proved additional collection to be unnecessary. The final step of the analysis phase was to consider relocating a clinic to an isolated or permanent Pod. This step
overlapped with our modeling phase.

The fourth phase of our project was the modeling phase. During this phase, it was concluded that three separate models would be generated in order to create recommendations:

- Model 1: Reassign rooms based on average data from fiscal year 2004
- Model 2: Reassign rooms based on physicians sharing rooms within clinics
- Model 3: Schedule rooms one day in advance based on actual patient scheduling

The models were created, tested, and reworked in order to establish the versions best suited for addressing this project's key issues. Once the three models were created, we established that moving a clinic entirely off-site would not be necessary because significant room savings existed in each of the three models created. The impacts of possible space reallocations were tested in this phase as well.

The final phase of this project was to form and justify recommendations for improvement. All findings and analysis were condensed to create the models. By analyzing these models and their impacts on the third floor of Taubman Medical Center and the Internal Medicine Department, we were able to justify that any of the three models would be beneficial. All three models saved at least 19 rooms each week, and the Internal Medicine Department should make the final decision regarding into which of the three models to integrate the clinics. As of the recommendation phase, the decision made by the client would reflect personal preference as opposed to performance.

**Data Analysis**

Raw patient data was extracted from the EWS database for the fiscal year 2004 and input into a Microsoft Excel spreadsheet. This data contained information with regard to appointment dates, creation dates for appointments, physician the appointment was for, clinic the physician was associated with and what time period the appointment was for. For the purposes of the models, the summary data that needed to be extracted from the raw data was the average patient per doctor per time period. This data was calculated by using Visual Basic procedures in Excel. The average number of patients per doctor per time period was determined by dividing the number of patients seen by a doctor by the number of times that the doctor was in clinic for that time period. Doctors that were in clinic less than 6 times for a given time period were given an average of 0 for that time period. This was done in an effort to eliminate outliers from the summary data. Further analysis was done in order to determine variance of patients seen by each doctor for each time period.

**Current Situation**

The Department of Internal Medicine, using existing data, creates a schedule for all of the clinics in Pods A, C and D for each day of the week to be used a month in advance. The schedule details which room is assigned to a single physician for a given day/time.
Physicians who will see more than 8 patients on a given day are allotted two rooms for use, and 7 or less patients guarantees one room. Exceptions exist where physicians need extra rooms for testing, fellows, nurse practitioners and other unique cases. In the current setup when physicians get overbooked, or book extra patients the day of the Medical Assistants must try to find extra rooms not being used by one of the other Pods, sometimes including Pod B a wholly separate entity. Often times, in these situations, physicians may have 2-3 rooms that are on opposite ends of a Pod, or even spread throughout the clinic space. Many Medical Assistants feel stretched in their duties as they spend large amounts of time worrying about scheduling and finding available rooms.

While clinics appear busy during many different days of the week, often times rooms are open, many times with the lights off and within easy view of physicians. According to administration, viewing open rooms is a concern that has been raised by the physicians, as they are frustrated that while their patients are waiting there are rooms open. Open or underutilized rooms are a seen as a byproduct of the scheduling system that in its current form is not flexible enough to allot these rooms that were previously assigned to one physician to one who needs extra room space.

**Considered Alternatives**

The current scheduling system of exam rooms used by the Internal Medicine department is believed to be highly inefficient. This is because each day there is a high volume of unused rooms coexisting with a high volume of exam space shortage. In order to alleviate this bottleneck and inefficiency, three models were drafted.

**Shared Room Model**

This model explored the possibility of assigning physicians fractions of rooms instead of complete rooms. Currently, a physician is allotted 1 room for every 7 patients that they see during one shift. Waste is created when multiple physicians have only 1 or 2 patients. They are each assigned one room, which is utilized for an hour or less and then left vacant and unused the rest of the day while other rooms are backed up with extra patients added on at the last moment.

By assigning physicians fractions of rooms based on the number of patients, and filling each exam room to its capacity of 7 patients, excess rooms were unmasked. Without assigning an overflow room to each clinic and just sharing exam rooms among physicians, the available exam time for additional patients increases. The general guidelines for the shared room model were as follows:

- Each exam room belongs to a specific clinic instead of a specific physician
- Each clinic will be self-contained
- Each exam room was filled to the capacity (7 patients per day)
- Physicians are split into neighboring rooms to reduce walking distances
- The difference between 7 and the number of patients assigned to an exam room is the number of additional patients that can be added to each exam room
- A clinic must be able to accommodate at least 4 additional patients for every 2
physicians on staff that shift. A floating room shall be assigned to a clinic needing extra space

Current Data Reassignment Model

The current data reassignment model employed the current scheduling discipline, but used data from Fiscal Year 2004 to determine how many patients, and thus how many rooms, a physician was assigned. It should be noted that for average patient data, all averages were rounded up, since a fraction of a patient does not exist. When data for a physician wasn’t present for the past fiscal year, the November 2004 Schedule data was used instead. The current guidelines of room allocation which were applied for this model were as follows:

- Each exam room belongs to a specific physician within a specific clinic (unless noted otherwise on the November 2004 schedule, where some physicians already share rooms)
- Each clinic will attempt to be self-contained
- Physicians are split into neighboring rooms to reduce walking distances
- All attempts were made to keep all physicians for a clinic in the same pod, and to keep all clinics in the same pod throughout the week

Daily Assignment Model Description

The goal of the daily assignment model was to assign doctor resources to room resources based upon the patient load on any given day. In essence, this model is an attempt to rectify the impact that patient load fluctuations for doctors have on room allocation for any given day. Primarily, there are two approaches to a model of this type:

- Time Based Model: This technique would be based upon average patient visit times. Based upon the type of visit, a time is assigned to each patient seeing each doctor in each Pod and rooms are scheduled according to those times.

- Policy Based Model: Rather than incorporate patient time, this model utilizes policies such as the one in current use to schedule patients. The significant difference between this model and current practice, however, is that rooms are scheduled on a daily basis instead of on a monthly basis.

For the scope of this project, a policy based model was chosen. A time based model would yield more accurate results for room allocation, but requires a significant amount of time to develop.

The approach to developing a policy based daily assignment model was to first examine patient to room ratios per period. Once these ratios are calculated, it was then possible to evenly distribute patients across the available room resources. One important aspect of this type of model was that the results will provide the best possible way to evenly
distribute the patient load across room resources. This model, however, may not provide the best possible method of scheduling rooms.

Another important factor to incorporate with this type of model was standard deviation of patients per doctor per time period. In order to account for a variety of factors that would cause the number of patients per doctor on any given day to deviate from the mean value, one standard deviation was added to the average number of patients per doctor per time period. The addition of one standard deviation to the average number of patients per doctor per time period had the overall effect of, in some cases, increasing the number of patients to be allocated for each room. The benefit of this addition is that the resultant schedule provides an excess supply of rooms for unplanned demand.

Findings and Conclusions

Generalized Findings

While each model is unique in its rules and application, several findings were common to all three models. One important note is that all three models were an improvement on the current situation. All three models resulted in a net room savings of at least 19 rooms per week. Given the current pressure and headaches surrounding room availability, this result was fundamental in highlighting the shortfalls of the current situation.

Over the course of interviewing both Clinic Leads and Medical Assistants, a reoccurring concern shared by many employees is the possibility of clinics moving offsite and losing access to resources found at the University Hospital and Taubman Center. However, our data analysis suggests that such actions would be unnecessary. Both our data analysis and anecdotal evidence from Clinic Leads and Medical Assistants indicate that the current resources are simply not being utilized efficiently, leading to empty rooms and patient back-ups.

Shared Model Findings

Model Methodology

By scheduling physicians according to a shared-room system, it was found that per half day session, an average of 14 exam rooms (range of 8.5 to 17.5) were emptied and made available for use. The best method by which to standardize room sharing is as follows:

- 0-5 patients/physician is assigned 0.5 rooms
- 6-7 patients/physician is assigned 1 room
- 8-12 patients/physician is assigned 1.5 rooms
- 13-14 patients/physician is assigned 2 rooms

By utilizing the above constraints, all physicians were successfully assigned to a pod with all physicians from the same clinic. No physician has to change their clinic day or time, which will reduce the inconvenience of the scheduling shift.
The large volume of extra rooms available with this model allows full flexibility when handling last-minute patient add-ons each day. Additionally, with the exception of one clinic on one day of the week, all clinics are able to stay in the same pod each half day session every day of the week. This will allow clinics to follow themselves, alleviating the backups caused by the morning-afternoon changeover. This will also help form a more tight knit relationship between physicians and medical assistants since they will work together everyday of the week.

One issue that must be addressed by the Internal Medicine Department is personality conflicts with the shift from the current scheduling system to this shared room system. Many physicians will be against the idea of sharing their exam rooms with other physicians, even if the other physicians are from the same clinic. The Internal Medicine Department would have to address this issue should this model be chosen for implementation.

**Summary of Savings**
In order to form an example of the shared room assignment model, scheduling data for the month of November, 2004 was utilized. The data, which was provided by the Internal Medicine Department, was verified using 2004 fiscal year patient data. Where data from 2004 showed zero patients or did not exist, scheduling data from November 2004 was utilized, but if the 2004 fiscal year data existed for a specific physician during a given day and time, that data was used. Table 1 summarizes the current room requirements per clinic, day, and time for the month of November 2004. Table 2 shows an example of savings by rescheduling the month of November 2004 utilizing the standardized method of assigning shared rooms.

**Table 1. November 2004 Current Room Requirements**

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<tr>
<th></th>
<th>Mon AM</th>
<th>Mon PM</th>
<th>Tue AM</th>
<th>Tue PM</th>
<th>Wed AM</th>
<th>Wed PM</th>
<th>Thu AM</th>
<th>Thu PM</th>
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<th>Fri PM</th>
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As demonstrated from the above tables, there is a savings of at least 0.5 rooms in every clinic curing every half day session for everyday in the business week. The savings per day and per clinic are shown below in Table 3.

Table 3. Shared Room Model-Savings Per Day and Clinic

<table>
<thead>
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<th></th>
<th>Mon AM</th>
<th>Mon PM</th>
<th>Tue AM</th>
<th>Tue PM</th>
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<tr>
<td>Pod B</td>
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<td>12</td>
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</tr>
</tbody>
</table>

From the above table, we see that the clinics saving the most space are Nephrology, Pulmonary, Rheumatology, and Cardiology. Across all clinics, an average of 17.6 rooms are saved in each clinic (range of 2.5 31.5). The periods in which the most exam space is saved are Monday afternoon and morning, Tuesday afternoon and Friday morning. There is an exam room savings of 14.5 rooms per half day session with a range of 8.5 to 17.5.

Current Data Reassignment Model Findings

Model Methodology
The current scheduling discipline rule is as follows: for every 7 or fewer patients, a doctor will be assigned one room. Thus, the following patient ranges were used to
allocate rooms according to this rule:

- 0-7 patients/physician is assigned 1 room
- 8-14 patients/physician is assigned 2 rooms
- 15-21 patients/physician is assigned 3 rooms
- 21-28 patients/physician is assigned 4 rooms

Several obstacles occurred by using the current discipline: clinics were not always in the same pod over the course of the week, and clinics had to be split up between two pods in order to accommodate the rooms allocated to each physician. The source problem for each of these obstacles lies in the model's lack

**Summary of Savings**

The current data reassignment model sought to test the accuracy of patient volume numbers currently used in the monthly schedules. By using averaged data over the entire Fiscal Year 2004, the data can be used to represent a typical month on the Third Floor of the Taubman Center. One note that should be repeated is that for physicians lacking data from the past fiscal year, data from the November 2004 schedule was used instead so as not to overlook those physicians.

With the current scheduling discipline in mind, and the data collected from either Fiscal Year 2004 or November 2004 numbers, the reassigned room requirements were calculated. Table 4 summarizes the findings from the current data reassignment model.

**Table 4. November 2004 Current Assignment Room Requirements**

<table>
<thead>
<tr>
<th></th>
<th>Mon AM</th>
<th>Mon PM</th>
<th>Tue AM</th>
<th>Tue PM</th>
<th>Wed AM</th>
<th>Wed PM</th>
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<th>Thu PM</th>
<th>Fri AM</th>
<th>Fri PM</th>
</tr>
</thead>
<tbody>
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<td>0</td>
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<td>0</td>
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<td>4</td>
<td>14</td>
<td>11</td>
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<td>0</td>
<td>18</td>
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<tr>
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<td></td>
</tr>
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</tbody>
</table>

Like the shared model, this reassignment model can be compared to the current room allocation schedule for November 2004. The savings that occurred as a result of the reassignment are summarized in Table 5. Negative numbers indicate that room allocation increased as a result of the current data reassignment.
Table 5. Current Reassignment Model - Savings Per Day and Clinic

<table>
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<tr>
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<th>Mon AM</th>
<th>Mon PM</th>
<th>Tue AM</th>
<th>Tue PM</th>
<th>Wed AM</th>
<th>Wed PM</th>
<th>Thu AM</th>
<th>Thu PM</th>
<th>Fri AM</th>
<th>Fri PM</th>
</tr>
</thead>
<tbody>
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<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Endocrine</td>
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<td>1</td>
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<td>3</td>
</tr>
<tr>
<td>Rheum</td>
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<td>1</td>
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</tr>
<tr>
<td><strong>Total</strong></td>
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<td>2</td>
<td>3</td>
<td>2</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

The above table of savings indicates that the clinics saving the most space are Nephrology, Endocrine, Cardiology, and Rheumatology. These clinics especially save space on those days where there are many practicing physicians, where savings accumulate over the group of physicians. The average savings per half-day is 5.4 rooms, with a range from 1 to 10 rooms. The average savings per clinic is 6.75 rooms, with a range from -1 to 15 rooms.

**Daily Assignment Model Results**

*Model Methodology*

The first step to developing the daily assignment model is to calculate the average number of patients per period for the entire department. This average is then divided by the number of rooms available for Pods A, C, and D (not including GI) to find the average patients per room for each time period. As can be seen from Table 6 patient room ratios for Pods A, C and D, excluding GI, fluctuate from 3 patients/room to 7 patients/room. The most important aspect of this model is that it exhibits the needs for daily scheduling. A static policy that assigns rooms based upon a fixed patient to room ratio will not evenly distribute patients to all available room resources.

Table 6. Patient-Room Ratios per Period*

<table>
<thead>
<tr>
<th></th>
<th>Mon AM</th>
<th>Mon PM</th>
<th>Tues AM</th>
<th>Tues PM</th>
<th>Wed AM</th>
<th>Wed PM</th>
<th>Thurs AM</th>
<th>Thurs PM</th>
<th>Fri AM</th>
<th>Fri PM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Ave</td>
<td>239.14</td>
<td>202.48</td>
<td>82.36</td>
<td>154.85</td>
<td>149.23</td>
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<td>134.73</td>
<td>160.76</td>
<td>171.15</td>
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<tr>
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<tr>
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<td>3.64</td>
<td>4.34</td>
<td>4.63</td>
<td>4.01</td>
</tr>
<tr>
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<td>5</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

* GI excluded from data and total rooms available is adjusted accordingly

Table 7 shows the patient to room ratios per period with the addition of one standard deviation to the averages. The table clearly shows that the addition of a standard deviation will have an impact on the policy to be implemented for a time period. The
increase in the ratio of patients to rooms, indicates that for any daily scheduling model, patient load variances must be accounted for.

Table 7. Patient-Room Ratios per Period with Addition of Standard Deviation

<table>
<thead>
<tr>
<th></th>
<th>Mon AM</th>
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<th>Tues PM</th>
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<th>Thurs AM</th>
<th>Thurs PM</th>
<th>Fri AM</th>
<th>Fri PM</th>
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</thead>
<tbody>
<tr>
<td>Total Ave</td>
<td>239.14</td>
<td>202.48</td>
<td>82.36</td>
<td>154.85</td>
<td>149.23</td>
<td>149.22</td>
<td>134.73</td>
<td>160.76</td>
<td>171.15</td>
<td>148.41</td>
</tr>
<tr>
<td>Std Dev</td>
<td>28.37</td>
<td>25.81</td>
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<td>74.62</td>
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<tr>
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<tr>
<td>Total Rooms</td>
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<td>37</td>
<td>37</td>
<td>37</td>
<td>37</td>
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<td>37</td>
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<tr>
<td>Ratio</td>
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<td>4.37</td>
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<tr>
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<td>7</td>
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</tbody>
</table>

As can be seen below in Table 8, the calculated room assignment policies is sufficient to meet departmental needs for each time period. In fact, for some time periods, the calculated policy results in fewer rooms needs than the capacity of 37 rooms.

Table 8. November 2004 Daily Assignment Room Requirements

<table>
<thead>
<tr>
<th></th>
<th>Mon AM</th>
<th>Mon PM</th>
<th>Tues AM</th>
<th>Tues PM</th>
<th>Wed AM</th>
<th>Wed PM</th>
<th>Thurs AM</th>
<th>Thurs PM</th>
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<th>Fri PM</th>
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</thead>
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<td>6</td>
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<tr>
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<td>36</td>
<td>31</td>
<td>32</td>
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</tbody>
</table>

Summary of Savings

By comparing the results of this model to the current method of allocating one room for every 7 patients, which is illustrated below in Table 9, we can see that the daily assignment model results in weekly savings of 36 rooms. At the same time, this model is also able to flexibly adjust to fluctuations in patient loads. This would indicate that currently, rooms are being scheduled for a need that does not exist. When this is considered along with observations and Clinic Lead feedback with regard to the issue of empty rooms, there would appear to be a solid basis for examining a daily scheduling methodology.
Table 9. Daily Assignment Model - Room Savings per Clinic and Day

<table>
<thead>
<tr>
<th></th>
<th>Mon AM</th>
<th>Mon PM</th>
<th>Tues AM</th>
<th>Tues PM</th>
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</tr>
<tr>
<td>Endocrine</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>14</td>
<td>-4</td>
<td>2</td>
<td>4</td>
<td>-4</td>
<td>-4</td>
<td>1</td>
<td>11</td>
<td>4</td>
<td>36</td>
</tr>
</tbody>
</table>

Recommendations and Implementation Strategy

The basis for our recommendations is what would be the best fit for the Department as a whole. The ideal model will correctly balance variables such as current culture in the workplace and resource needs. Each model gives different weights to these variables, which must be considered before choosing which model to implement. Table 10 shows a brief comparison and contrast between the models presented in this report.

Table 10. Model Comparison/Contrast

<table>
<thead>
<tr>
<th>Model</th>
<th>Pro’s</th>
<th>Con’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Assignment</td>
<td>- Simple assignment rules</td>
<td>- Assigning a room to MD’s with few patients for the whole period</td>
</tr>
<tr>
<td></td>
<td>- Exam rooms uniquely belong to one physician</td>
<td>- Clinics are not self-contained</td>
</tr>
<tr>
<td></td>
<td>- Reduction in number of rooms needed</td>
<td>- No availability for flex rooms</td>
</tr>
<tr>
<td>Shared Model</td>
<td>- ~3 times the savings of current room allocation</td>
<td>- Requires shift in culture</td>
</tr>
<tr>
<td></td>
<td>- Clinics are self-contained</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Ample room to accommodate add-on’s</td>
<td></td>
</tr>
<tr>
<td>Daily Assignment</td>
<td>- More efficient room scheduling for 9 out of 10 time periods</td>
<td>- Requires significantly more effort for development of a room schedule</td>
</tr>
</tbody>
</table>
With this basis in mind, it is our recommendation that the Internal Medicine Department implement the shared model. The reasoning for this recommendation is based upon the large amount of weekly room savings and the dramatic increase in overall efficiency with room utilization. Again, a cultural shift regarding room exclusivity for physicians is necessary for the shared-room model to be successfully applied in practice. However, there are numerous benefits to this model which are each significant in reducing workplace stress, confusion, and inefficiency.

Should the shared-room model be implemented, the key events would be as follows:

- Adoption of model
- Presentation of model to Department of Internal Medicine faculty and staff
- Education/Training
  - Clinic meetings
  - Policy manuals
  - Materials emphasizing positive aspects of shared model
- Creation of monthly template for use in scheduling purposes
- Implementation of model for a trial period
- Re-evaluation of model parameters, making changes as necessary
- Full-scale implementation by July 2005

Recommendations for Further Study

Throughout the several interviews with Medical Assistants and clinic Medical Assistants, as well as the key observations made within the individual Pods, it was concluded that several improvements not directly related to any of the three recommended models would make the Internal Medicine department significantly more efficient. Although quantitative analysis on the following recommendations was not completed, further studies could lead to additional improvement in the space allocation of the third floor of Taubman Medical Center. Future studies should concentrate on:

Relocating Pod B

Although the clinics within Pod B are independent from the Internal Medicine department, it would prove valuable to consider relocating them. Currently, Pod B is located in the middle of Pods A and C. This leads to an isolation of Pod A exam rooms, and decreases the fluidity with which the three Internal Medicine Pods may share rooms. A very low level improvement to this would be to shift Pod B to either end of the third floor (either to the right of Pod A or the left of Pod D when facing the reception area). This would allow more fluidity and communication between Pods A, C, and D, and would act as an immediate solution to room shortages and locating extra open rooms.

After talking to three different Medical Assistants in Pods A and C, it was suggested that moving Pod B off-site would also alleviate some of the overflow and system clogs. The old children’s psychiatric ward was suggested as a viable option for relocating Pod B. The impact of moving Pod B, both within the third floor or off-site, does not fall within the scope of this project and thus was not examined. Possible impacts of this consideration include: gaining additional exam space and reducing patient wait times as
well as system back-ups with respect to patient scheduling.

**Increasing Medical Assistant Staff**

Two Medical Assistants were observed in each Pod during every observation timeframe. One Medical Assistant was always working on patient flow (the steps occurring between patient registration and the patient actually seeing a physician), although both Medical Assistants shared this job. The other Medical Assistant tended to the patients and physicians, giving vaccinations and performing or assisting with the various procedures done on site in each clinic.

Investigation into the assignment and duties of Medical Assistants, as well as input from the staff has led to the recommendation of increasing the Medical Assistant staff. Interviews with the Medical Assistant staff indicated that much of a patient’s wait time is caused by waiting for the medical assistant to perform a task. For example, an injection should only last a couple of minutes, but patients wait between 15 and 20 minutes waiting to receive it. Because this duty is performed by a medical assistant, patients must wait until one becomes available. This limitation and the fact that one medical assistant must always be completing patient flows leads to a backup of patients in waiting rooms. This reduces the total amount of available time physicians could be using exam rooms and, by inference, also reduces the total number of exam rooms required by each clinic. Possible impacts of providing more Medical Assistants to each Pod include decreased wait time for patients sitting in exam rooms and, more relevant to this project, decreased number of required rooms per clinic. These impacts can be verified with future study in this area.

**Sharing Room Information between Clinics and Pods**

Currently, no system exists in the Internal Medicine Department that allows clinics, or Pods to share information regarding room utilization. Although this was not explicitly tested, this lack of communication seems to help hide vacant exam rooms and cause clinics, and by association, Pods, to not only experience patient backup, but to inefficiently schedule patients in.

If a system was installed which showed the location and availability of each exam room allotted to the Internal Medicine Department, scheduling centers could utilize this information and more efficiently schedule last minute and overflow patients. This system would also help identify which clinics are consistently receiving too many exam rooms, and which are receiving too few. This information would serve as a check for continuous improvement as room allotment could be revised when patterns of overuse or under-use become apparent.

**Implementing Software Solutions to Improve Scheduling**

The current scheduling system involves creating schedules on a monthly basis. This approach does not account for variability of patient volume within a smaller timeframe, such as a weekly or daily basis. Increasing the availability of this patient volume data would allow for monitoring and adjustments to be made to the schedule.
By using software, weekly reports can be generated for a real-time perspective of patient flow through the Pods. Even creating an automated database process for generating these reports can be created from existing software, eliminating the cost of purchasing new software packages.

Re-evaluating Physical Room Utilization

One statistic not explored in our study was physical utilization of the exam rooms in the Pods. Gaining accurate information for utilization requires a significant of manpower and time in order to get direct observations. This type of study could feasibly be conducted by a student group similar to ours. Understanding the room utilization across both Pods and across clinics is key to creating an accurate room schedule, and would be worth the effort necessary to successfully gain this information.