

# Improving Clinical Access and Continuity through Physician Panel Redesign

**Hari Balasubramanian, Ph.D.<sup>1</sup> Ritesh Banerjee, Ph.D.<sup>2,\*</sup> , Brian Denton, Ph.D.<sup>3</sup>,  
James Naessens, Sc.D.<sup>2</sup>, Douglas Wood, M.D.<sup>2</sup>, James Stahl, M.D.<sup>4</sup>**

*<sup>1</sup>Department of Mechanical and Industrial Engineering, University of Massachusetts,  
Amherst MA; <sup>2</sup>Division of Health Care Policy and Research, Department of Health  
Sciences Research, Mayo Clinic, Rochester MN;; <sup>3</sup>Department of Industrial and Systems  
Engineering, North Carolina State University; <sup>4</sup>Institute of Technology Assessment,  
Massachusetts General Hospital.*

*\* Dr. Banerjee completed this paper while working at the Mayo Clinic. His current  
affiliation is Analysis Group, Inc., 111 Huntington Ave., 10<sup>th</sup> Floor, Boston, MA, 02199*

Correspondence to: Hari Balasubramanian

Department of Mechanical and Industrial Engineering

University of Massachusetts at Amherst

160 Governors Drive

Amherst, MA 01003

413.577.3208 (Tel) 413.545.1027 (Fax)

Email: [hbalasubraman@ecs.umass.edu](mailto:hbalasubraman@ecs.umass.edu)

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# **Improving Clinical Access and Continuity through Physician Panel Redesign**

**Running Title:** Improving access through panel redesign

## **ABSTRACT**

### **Word Count: 198**

#### **Background:**

Population growth, an aging population and the increasing prevalence of chronic disease is projected to increase demand for primary care services in the United States.

#### **Objective:**

Using systems engineering methods, re-design physician patient panels targeting optimal access and continuity of care.

#### **Design:**

We use computer simulation methods to design the physician panels and model a practice's appointment system and capacity to provide clinical service. Baseline data was derived from a primary care group practice of 39 physicians with over 20,000 patients at the Mayo Clinic in Rochester, MN for the years 2004-2006. Panel design specifically, took into account panel size and case-mix (based on age and gender).

#### **Measures:**

The primary outcome measures were patient waiting time and patient/clinician continuity. Continuity is defined as the inverse of the proportion of times patients are redirected to see a provider other than their primary care physician (PCP).

#### **Results:**

The optimized panel design decreases waiting time by 44% and increases continuity by 40% over baseline. The new panel design remains more efficient (lower waiting time, higher continuity) over a wide range of practice panel sizes.

#### **Conclusions:**

Redesigning primary care physician panels can improve access to and continuity of care for patients.

## **INTRODUCTION**

The U.S. faces a shortage of primary care physicians (PCPs) (1); a result of increasing clinical demand in an aging population, and the shrinking number of PCPs likely to be in practice in the near future. (2) Timely access and continuity of care, two key goals of primary care practices, have suffered. Insufficient primary care access will have serious consequences. For example, it is estimated that 40% of emergency department visits result from patients not being able to access their PCP in a timely fashion. (3) From 1997 to 2001, the percentage of people reporting being unable to obtain a timely appointment with their PCP rose from 23% to 33%. (4).

Continuity of care also suffers with fewer PCP and this too has serious consequences. Patients who regularly see their own PCPs are more satisfied with their care, more likely to take medications correctly and less likely to be hospitalized (5, 6, 7, 8). Lack of continuity also reduces the efficiency and effectiveness of care and can increase the number of follow-up appointments. (9,10)

To address some of these issues many primary care practices have tried implementing *advanced access*. (11, 12) Advanced access promotes the concept that physicians should “do today’s work today” rather than push appointments into the future. Because of the intrinsic variability in patient demand, the supply of physician time needs to be sufficiently greater than demand for advanced access to work. (13, 14)

Proponents of advanced access (AA) claim that since patients are offered appointments on the same or next day, wait times are shorter. Moreover, since AA works with an individual physician’s calendar, the patient tends to see their own physician more frequently, facilitating continuity. (15, 16) However, several studies have documented significant barriers to successful implementation of AA. (17, 18, 19) These difficulties

include the difficulty working through existing backlogs; adequate follow-up care in panels with large proportions of chronically ill patients (20); and maintaining continuity of care, since prioritizing speed of access comes at the cost of less continuity (21, 22).

AA implicitly assumes each physician is an independent entity. However, solo-physician practices have limited options for dealing with the inherent variability of appointment demand. To work in periods of high demand physicians need to choose between extending office hours (flex hours) or create an appointment backlog. In group settings, however, transient imbalances between supply and demand can be addressed temporarily by shifting demand to less busy clinicians within the same practice.

We present a computer-based simulation model demonstrating the improvements in timely access and continuity that can be realized by redesigning physician panels in a group practice. How might the design of a physician's panel affect the "efficiency" of a practice? Size matters but size alone is not the only factor; together, the number of patients in a panel and their disease burden determine the panel's aggregate demand for access. Restructuring panels allows a group practice's supply to collectively be in better balance with patient demand for access. We show how choosing the best combination of panel size and composition will reduce total patient waiting time and increase the frequency with which patients see their own provider.

## **METHODS**

### **Baseline data**

We collected appointment and physician availability data from the panels of a primary care group practice at the Mayo Clinic in Rochester, Minnesota from 2004 to 2006. The practice consisted of 39 physicians and covers approximately 20,000 patients

living in Olmsted and surrounding counties. Figure 1 illustrates the distribution of weekly visits for three categories of patients – women (63-68 y.o.), women (38-43 y.o.) and men (63-68 y.o.). The three distributions illustrate how differences in appointment request rates can vary with gender and age.

For our analysis, we grouped patients by gender and age, as suggested by Murray (14). Age was further subdivided into 14 age categories of five-year increments starting at age 18 y.o. up through age 83 y.o., for a total 28 patient categories.

The 39-physicians in the Mayo (Primary Care Internal Medicine) PCIM practice cover 20,000 patients. The practice group is equivalent to 17 physicians working full time, after accounting for part-time and other activities (e.g., education and research). The average panel size for this practice is approximately 1200 patients per physician. To obtain panel sizes more representative of the typical practice (~ 2000/provider (23)), we inflated the total empanelled population to 34,000 by sampling, while keeping the proportion of people in the different demographic categories the same. The FTE adjusted panel size thus increased from 1200 per physician to about 2000 per physician on average. The composition of patients in the new panels is unchanged relative to the original panels.

### **Optimization Model Description**

Panel design is an allocation problem: given a set of health categories (e.g., age, gender, comorbidities), and a given number of physician panels in a group practice, how many patients from each category should be allocated to each panel?

Figure 2 illustrates a simple example with three patient categories and three physician panels. The three categories have a total of 1500, 1500 and 3000 patients,

respectively. The number of patients from each category assigned to each physician's panel is indicated by the arrows in the figure. Two numbers are associated with each physician (hanging squares): the number of available slots in a day and total appointment requests in a day. In our example, the physician can see a maximum of 20 patients in a day. The number of daily requests is assumed to be 1% of the patients in each category directed at each physician. The dashed lines indicate redirected patients, i.e., patients who do not get an appointment with their own physician but can be reallocated to some other physician in the practice that same day or to their own physician the next day. The cost of redirection is loss in continuity or lack of timeliness. The panel design in this example is not optimal. Physician 3 in particular has too many patients in her panel. However, if the number of category 3 patients were reallocated to 1200 for panel 1, 1400 for panel 2 and 400 for panel 3, all patients would see their own PCP in the same day (see Figure 3) without decreasing the number of patients served.

Redesigning physician panels can thus reduce workload while simultaneously improving access (equivalently minimize waiting time) and continuity of care. If a physician's panel is poorly designed, her patients will likely fail to secure a timely appointment and will tend to see other physicians – thus both timeliness and continuity suffer. By redistributing the patients across panels, each physician's supply becomes better matched with demand. The model's complexity increases when there are multiple days and physicians have a varying capacity over time due to vacations or other commitments. Furthermore, the number of appointment requests for each panel is unknown in advance.

## **Methods**

To find the optimal panel design, we use a computer based simulation model which we solve using numerical optimization techniques. (23) Such methods are an important methodological area within the field of systems engineering, and have been applied to many problems in other service industries including the design of financial portfolios, design of transportation systems, and airline management. The computed optimal panel design is evaluated over one simulated year which allows us to calculate summary statistics such as average waiting time and the number of redirections to other providers.

Our model works in the following manner: physicians start with an empty weekly calendar. In each week, patients make appointment requests that are satisfied on a first-come-first-served basis; unfulfilled requests from the previous week are filled first. Ties between requests in the same week are broken with a random draw. When a physician's calendar in a week is full, patients can either choose to wait for a future week to see their own provider, or they can see another physician in the same week (provided capacity is available). If capacity is not available, extra slots are added to accommodate these patients. These extra slots represent the additional hours put in by a non-PCP physician to cover the demand.

In our model, our baseline assumption, based on the rate observed at the Mayo Clinic, is that 40% of patients when given the option will choose to see an alternative PCP now rather than wait. In essence, these patients may represent acute-care patients with immediate needs, for whom timeliness is more important than continuity. The remaining – presumably chronic care patients for whom continuity is more valuable – are willing to wait to see own PCP. In our model, those patients redirected to other physicians are subsequently redirected back to their own PCP rather than follow up with

the new PCP. This reflects that fact that seeing another physician generates additional follow-up appointments. (23)

In our simulation, we sample randomly from historical visit data for each of the age and gender categories from 2004-2006. Each physician has a weekly schedule that we use to determine weekly capacity. The results we present are averages of 200 replications of the simulation for each design.

### **Panel Strategies**

We compare the results from our optimal panel design arrived at using simulation with two other panel strategies. The first, which we call the *baseline design*, is the design currently used by the PCIM practice. The second is a *capacity-based panel design*.

The capacity-based design is a straightforward allocation strategy that allows us to evaluate the performance of a practice in which patient panels are balanced based on average physician capacity. The capacity-based panel design is constructed as follows: first, we tabulate each physician's average share of the total average weekly capacity (available appointment slots) of the group practice. For example, if physician "A" sees patients on average for 40 hours a week out of a total of 200 hours of patient-time by the group (5 PCP practice), her share is 20%. Each PCP receives a proportion of patients from each patient category equal to the proportion of time he or she is available to see patients.

In addition to wait time and continuity, we also report the total utilization of the clinic, the number of total slots filled over total slots available. The number of extra slots (additional capacity) that the clinic needed on a weekly basis to meet demand are included in this calculation.

## **Sensitivity analysis**

### *Adding new patients to the practice*

As the demand for primary care doctors increases in the United States, practices are routinely faced with decisions regarding whether to empanel new patients. Young patients (less than 35 y.o.) of either gender tend to use appointments less frequently than older patients. For our first sensitivity analysis, we increased the proportion of young patients by 25% keeping everything else the same. This increased the total patient pool by 3500 patients. We then analyzed how the different panel designs perform under this scenario.

## **RESULTS**

### **Baseline Design**

For the base-case scenario the mean waiting time was 0.57 weeks (4 days) and there were on average 266 redirections to other physicians per week. For the capacity-based design scenario the mean waiting time of 0.39 weeks (2.73 days) and 182 redirections to other physicians per week; 32% better in wait time and the number of weekly redirections relative to the baseline. The optimized design reduces wait time and redirections by 40% compared to the baseline parallel previous sentence and add numbers. (Table 1). With regard to utilization, the optimized design and capacity-based design required fewer extra slots to be created than the base-case and had a higher number of unfilled slots on average per week (spare capacity) (Table 2).

### **Increasing Panel Size**

Wait times and redirections increase across all scenarios as panel size increases. In sensitivity analysis, the optimized design remained dominant over the base-case up to an additional 2000 patients (for the whole clinic). This remained valid with up to 3000 additional if patient category was restricted to low-request patients (Table 3).

### **Adding categories**

Though age and gender are good proxy measures for case-mix, more specification can be useful. We used Classification and Regression Tree (CART) Analysis (24) to identify conditions in addition to age and gender that might be significant predictors of visit rates. Our analysis of the clinic data revealed that coronary artery disease (CAD), hypertension and depression were three categories strongly predictive of visit rate. In conjunction with age and gender, we identified 15 categories based on these factors that could be used to categorize patients. Results for panel designs under this new patient classification are shown in Table 4. While the wait time and number of redirections are somewhat different, Optimal Design is still 40% and 36% better respectively in the two measures than the base case.

### **DISCUSSION**

Optimally redesigning panels has the potential to reduce wait times and maximize continuity. Our system better matches physician capacity with historical demand from each category of patients, than the other strategies considered. Physicians who have less spare capacity in their schedules are given proportionally fewer patients from more appointment intensive categories and vice versa. The capacity-based design also performs

quite well relative to the base-case for the same reason: physician capacities under this method are better matched with appointment demand than in the base-case.

Panel redesign can be used to bolster the implementation of advanced access by helping physicians work through legacy demand. For example, (figure 2) it is often difficult for a physician with a large number of patients (Physician 3) to “do today’s work today”, even with flexible additional same day capacity. By redistributing patient demand with due consideration to case-mix, practices can meet the goals of advanced access while minimizing the disruption of the changing from one practice pattern to another..

The optimized panels do this by increasing the effective capacity of primary care practices: as demand for appointments is better matched to capacity, many patients, who would otherwise wait to see their own provider, no longer need to wait. In addition, fewer follow-up appointments need to be made. Both these factors increase the number of available slots in future periods.

Our study has some limitations. We do not consider individual patient and physician preferences which may play a role in how panels are formed. In principle, practice managers could take these preferences into account, along with other factors described above, when designing panels. More importantly, panels are dynamic since over time, people age, are diagnosed with new conditions, and enter or leave the system for reasons other than their health. Good panel design should anticipate these changes. Indeed, a useful by-product of this constant state of flux is that opportunities exist to make incremental changes to the current panel design to transition to a more efficient design. In other words, existing panels could be reconstituted as patients enter or leave the practice.

In addition there are other models of care delivery which we do not consider in this initial analysis, for example, *group visits* (25). In this setting, planned visits for chronic illness care can be delivered in quarterly group visits for some patients, while acute illnesses are still addressed with one-on-one encounters. By seeing 10-15 patients in a single session that is around 60-90 minutes, a physician will be able to open up previously unavailable capacity. As a result, panels can be larger and may be able to accommodate more patients with chronic conditions. Such a care delivery model may prove more efficient than panel redesign. Our modeling framework has the potential to be extended to such a delivery system.

Lastly, we do not account for complex operational issues that may occur on a daily basis, including cancellations and no-shows – both of which are an important component of the regular running of an office practice.

## **CONCLUSIONS**

There is a large set of policies that may help address the problem of primary care access shortage. These include alternative models of care, payments for coordination of care, computer based care and other tools to facilitate non-visit care and self-directed care for some patients. No one policy or intervention will solve the problem by itself.

We believe that increasing the effective capacity of physicians using systems analytic methods is not only an important part of the solution but also a very cost-effective approach that should contribute to the better health status of patients in the panel.

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**Table 1. Baseline, Optimal and Capacity-based Designs**

	<b>Wait Time</b>	<b>Redirections</b>
	<b>Baseline Design</b>	
<b>Mean</b>	0.572	266.65
<b>95% CI</b>	(0.570, 0.574)	(265.34, 267.96)
	<b>Capacity-Based Design</b>	
<b>Mean</b>	0.391	182.04
<b>95% CI</b>	(0.390, 0.392)	(180.99, 183.08)
	<b>Optimal Design</b>	
<b>Mean</b>	0.318	160.50
<b>95% CI</b>	(0.316, 0.320)	(159.13, 161.87)

*CI* stands for Confidence interval. *Wait Time* is the average wait time in weeks for each patient. Redirections is the average number of times patients requesting care saw a physician other than their own PCP in a week.

**Table 2. Utilization under the three designs**

	<b>Extra Slots</b>	<b>Unfilled Slots</b>
	<b>Baseline Design</b>	
<b>Mean</b>	122.02	35.71
<b>95% CI</b>	(113.48, 130.55)	(33.29, 38.12)
	<b>Capacity-Based Design</b>	
<b>Mean</b>	103.64	52.55
<b>95% CI</b>	(93.71, 113.56)	(49.89, 55.20)
	<b>Optimal Design</b>	
<b>Mean</b>	100.53	57.93
<b>95% CI</b>	(90.90, 110.15)	(55.13, 60.73)

*CI* stands for Confidence Interval. *Extra Slots* represents the average additional number of 20 minute appointment slots needed per week to satisfy demand, while *Unfilled Slots* represents the average number of 20-minute appointment slots that went unutilized in a week

**Table 3. Effects of Increasing Panel Size**

		Baseline		Capacity-based		Optimal	
		Wait Time	Redirections	Wait Time	Redirections	Wait Time	Redirections
<b>Current Demand</b>	<b>Mean</b>	0.572	266.65	0.391	182.04	0.318	160.5
	<b>95% CI</b>	(0.570, 0.574)	(265.34, 267.96)	(0.390, 0.392)	(180.99, 183.08)	(0.316, 0.320)	(159.13, 161.87)
<b>10% Higher Demand</b>	<b>Mean</b>	0.749	437.32	60.07	285.55	0.512	254.55
	<b>95% CI</b>	(0.746, 0.751)	(435.05, 439.59)	(60.01, 60.13)	(283.7, 287.4)	(0.509, 0.515)	(252.02, 257.07)

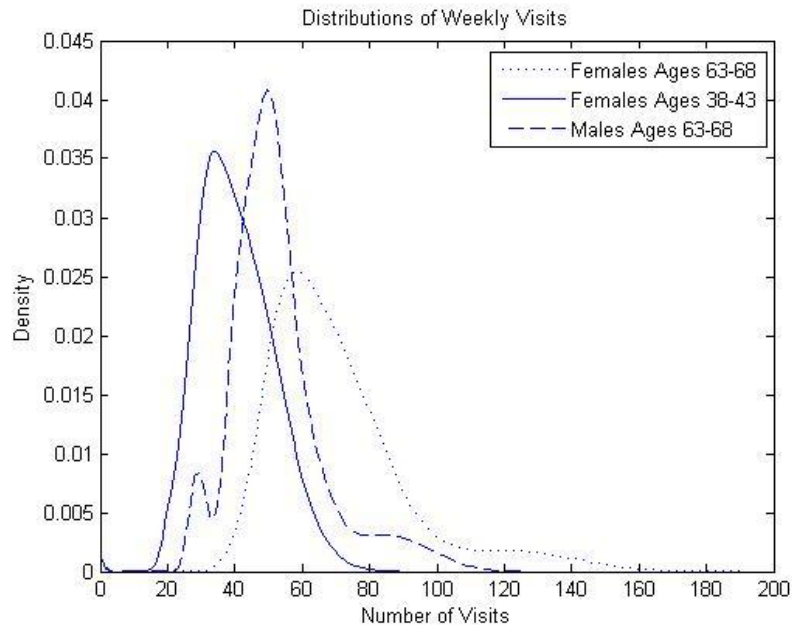
Three panel designs (Baseline, Capacity-based, Optimal) are compared under current and 10% increased demand. *CI* stands for Confidence interval. *Wait Time* is the average wait time in weeks for each patient. *Redirections* represents the average number of times patients requesting care saw a physician other than their own PCP in a week.

**Table 4. Baseline, Optimal and Capacity-based Designs Under an Alternate Patient Classification**

	<b>Wait Time</b>	<b>Redirections</b>
	<b>Baseline Design</b>	
<b>Mean</b>	0.602	293.81
<b>95% CI</b>	(0.600, 0.604)	(291.92, 295.70)
	<b>Capacity-Based Design</b>	
<b>Mean</b>	0.419	203.60
<b>95% CI</b>	(0.417, 0.421)	(201.96, 205.24)
	<b>Optimal Design</b>	
<b>Mean</b>	0.362	190.53
<b>95% CI</b>	(0.359, 0.364)	(188.60, 192.47)

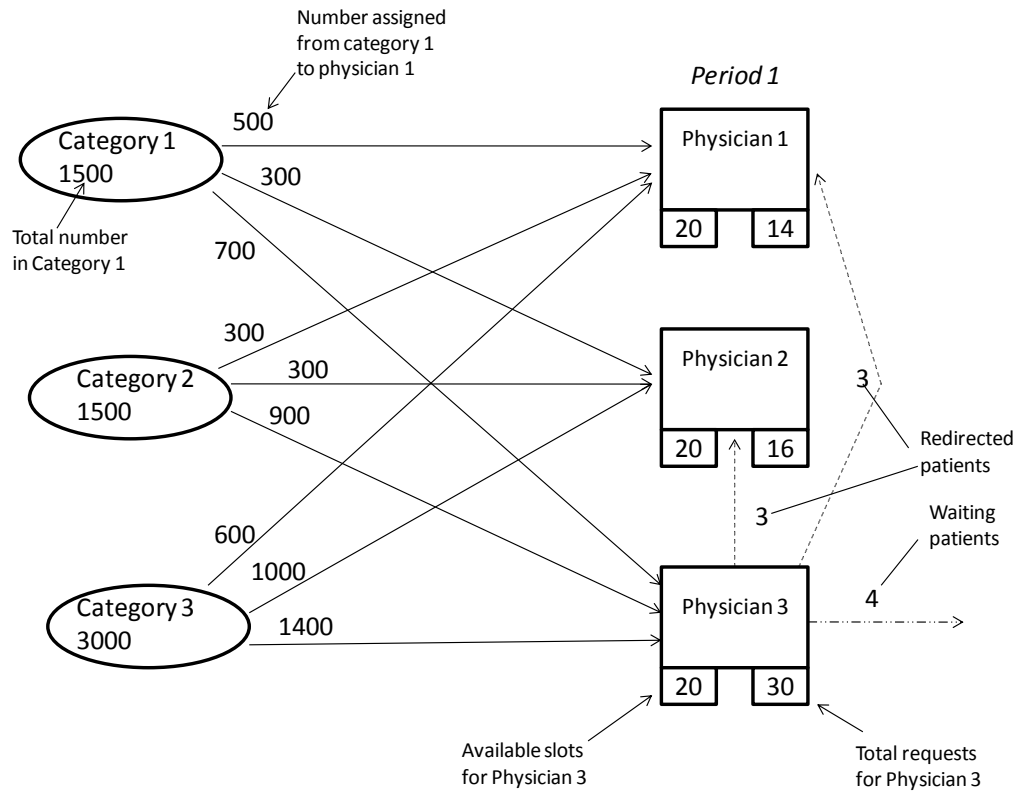
Alternate patient classification is based on age, gender, coronary artery disease (CAD), hypertension and depression. *CI* stands for Confidence interval. *Wait Time* is the average wait time in weeks for each patient. *Redirections* represents the average number of times patients requesting care saw a physician other than their own PCP in a week.

**Figure 1. Distributions of Weekly Visits.**



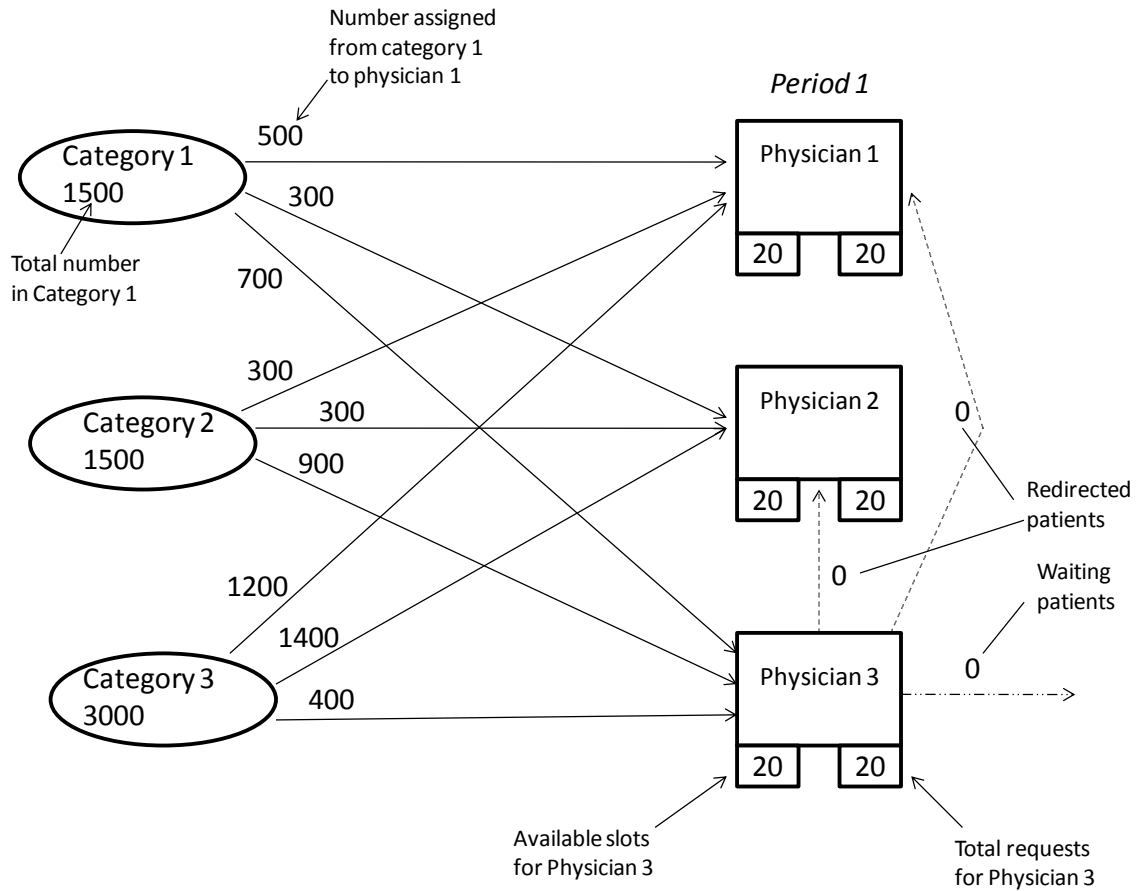
Probability distributions of weekly visits for three different patient age and gender categories, based on historical data. Differences in distributions can be observed between males and females of the same age group as well as females across different age groups.

**Figure 2. Panel Design Example - Part I**



Stylized example illustrating how poorly designed panels can lead to redirections and waiting. This example is for one day. The number of daily requests is assumed to be 1% of the patients in each category directed at each physician. Note that all the redirections are waiting happen with regard to Physician 3 who has too many patents.

**Figure 3. Panel Design Example – Part II**



Stylized example illustrating how panels can be redesigned to simultaneously improve redirections and waiting. This example is for one day. The number of daily requests is assumed to be 1% of the patients in each category directed at each physician. In this figure, we redesign the panels shown in Figure 2. Specifically, the number of category 3 patients were reallocated to 1200 for panel 1, 14000 for panel 2 and 400 for panel 3 (as opposed to 600, 1000, 1400 in Figure 1), all patients would see their own PCP in the same day. Note that with the redesign no patients are redirected or wait.