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Choosing Number And Scheduling Priority Of Warm-Hand Offs: A Des Model

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Abstract

Background: The integration of behavioral health care into primary care is being promoted as a means to treat more people with behavioral health problems where they are most likely to be seen. Clinics with traditional behavioral health services may open slots among scheduled appointments to see these "warm-hand off" (WHO) patients identified by primary care providers (PCPs). The effects of giving priority for behavioral health appointments to either scheduled or WHO patients and of the number of appointments left open for WHO patients are investigated in this project.

Methods: A discrete event simulation model was built of a moderately integrated clinic. WHO patients arrive randomly, on average 4 per day per PCP, and wait to see behavioral health providers (BHPs) who also see scheduled patients. Simulations of four clinic sizes, with PCP to BHP ratios of 1:1, were run. Effects of queue discipline (priority is given to scheduled or WHO patients) and the number of open WHO slots (3 or 5) are analyzed. Outcomes include the percent of scheduled patients served, the percent of WHO patients served, and the percent of BHP utilization.

Results: In clinics with 1 PCP and 1 BHP, for 3 and 5 open slots respectively, giving priority to WHO patients resulted in 80.6% and 81.0% of WHO patients served and 84.4% and 86.6% of scheduled patients served, however, giving priority to scheduled patients resulted in 97.8% and 98.1% of scheduled patients served, but 32.0% and 47.9% of WHO patients served. A similar pattern was seen for larger clinics, though the percent of WHO patients served increased for both 3 and 5 open slots with clinic size. Having 3 or 5 open slots led to few differences when WHO patients were given priority, but when scheduled patients were given priority, choosing 5 open slots rather than 3 open slots, increased the percent of WHO patients served by 15-20 percentage points across the clinic sizes. In either queue discipline, changing from 3 to 5 open slots reduced the percent of BHP utilization by approximately 8 percentage points for all clinic sizes. When WHO patients were given priority, the average wait time for scheduled patients increased from approximately 2-5 minutes to 13-19 minutes across clinic sizes.

Conclusion: These results might suggest to some clinics attempting to integrate primary care and traditional behavioral health services to choose to give WHO patients priority. However, it is recognized that there are costs associated with not seeing both scheduled and WHO patients, and clinics making this decision will have to weigh these tradeoffs. The analysis of these results provides one framework to assist in choosing between different arrangements for integration.

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Introduction

Background

Behavioral health issues can complicate the management and worsen outcomes in chronic medical illnesses[1]. However, most people with behavioral health disorders in the United States remain untreated or poorly treated[2]. People with behavioral health problems are more likely to present to primary care providers (PCPs) than behavioral health providers (BHPs), and thus there is an opportunity for PCPs to identify and treat common behavioral health issues in primary care[1]. Already many PCPs are treating behavioral health disorders in primary care, however, the care of behavioral health disorders in primary care clinics can fall below quality standards[3,4]. The integration of primary and behavioral health care is now being promoted as a way to address these issues, including by some federal agencies such as the Substance Abuse and Mental Health Services Administration-Health Resources and Services Administration Center for Integrated Health Solutions (SAMHSA-HRSA-CIHS)[5,6]. The Patient Protection and Affordable Care Act also includes numerous provisions and incentives to encourage integration[7,8].

There is growing evidence that integrated care can provide better outcomes than usual primary care[9-11]. Integrated care has been shown to improve depression management and other mental health disorders in primary care[9,10,12], and outcomes in some chronic medical illnesses[10,13]. However, even though integration has shown some positive effects, the degree of integration has not been shown to significantly predict outcomes[1,9,14]. Many questions remain about which factors involved in integration actually mediate the improvements in care that have been seen[14,15].

The term “integration” has been applied to various organizations of health systems and a number of models of integrated care have been proposed[5,16]. The SAMHSA-HRSA-CIHS has advanced a framework of 6 levels that describes a continuum of integration based on the degree of communication, collaboration, and coordination of space, systems, and practices[5]. In this scheme, the most integrated clinics have PCPs and BHPs working together in the same clinic. The BHPs are available for “warm-hand off” (WHO) appointments to quickly meet patients identified by PCPs with behavioral health issues to start assessment, triage, and interventions[17]. A few clinics are using various versions of this very integrated model and there is some evidence that WHOs increase patients’ engagement with and the follow-up for behavioral health care[18,19].

At the same time, it is recognized that not all healthcare centers can easily increase their level of integration[5]. Primary care and behavioral health services evolved separately, and combining their services and perspectives into a single, integrated system will require huge administrative, political, financial, and cultural changes; thus step-wise transitions are more to be expected[5,20]. This author, as part of her summer internship project for the Masters degree at the Yale School of Public Health, interviewed leaders at a number of community health centers in Connecticut to assess the clinics' level of integration. Eleven of the twelve clinics had not yet reached the "integrated" level of the SAMHSA-HRSA continuum. If a clinic was considering or attempting integration at all, it entailed coordinating a traditional behavioral health service with primary care. Some clinic leaders were considering how to make behavioral health time open for WHO patients. However, many questions, such as how many appointments should be left open for WHO patients and whether scheduled patients or WHO patients should get priority for BHPs' appointments, are as yet unanswered.

Proposal

This project uses discrete event simulation (DES) software to build a model of a moderately integrated clinic in order to assess the system's performance under a range of different staffing, scheduling, and queue discipline scenarios. Three main parameters will be varied. First, the effects of two queue disciplines where priority is given to either scheduled patients or WHO patients are analyzed. Second, the impact of varying the number of open WHO slots is examined. Third, whether any efficiency is gained by increasing the size of the clinic is assessed. The main outcome variables include the percent of scheduled patients served, the percent of WHO patients served, and the percent of BHP utilization. The results are presented and the tradeoffs among the options are discussed. It is hoped that this project will provide clinics considering integrating further one method to assist them in choosing between alternative arrangements. These issues are considered from the perspective of a clinic director planning operations to best address the needs of the population served. Other important issues, such as cost-effectiveness, facility capacity utilization, long-run physical and mental health outcomes, and patient satisfaction are not directly investigated, but are considered when discussing the tradeoffs.

Review of Relevant Studies and Theory

Waiting Times and Behavior

In this model, two types of patients may end up waiting in a queue. The number of people waiting in a line and the wait time can affect both whether someone will get into a line initially or just leave (balk) or will get into the line but leave after a period of time waiting (renege). Balking and reneging can lead to patient dissatisfaction, loss of revenue, and risks of adverse events occurring, though small and hard to quantify[21]. Long wait times are linked to dissatisfaction and a lower likelihood of coming to future appointments in outpatient settings[22]. The most common reason for leaving-without–being–seen (LWBS) from emergency departments (ED) is long waiting times, but the length of the queue is also among other causes[23-26]. Long wait times are better tolerated when the service is seen as valuable and patients who LWBS may have conditions of lower urgency and acuity[26]. People are sensitive to fairness and get dissatisfied if people leave who arrived after them[21]. People accept letting sicker people go first, yet the arrival of sicker patients can increase reneging, because it may signal increased waiting time[21]. Therefore, an acceptable wait time for patients depends on many factors. Other stakeholders in the healthcare system, such as payers, CEO/CFOs of clinics, providers, and regulatory bodies, all with different perspectives and objectives, may each have varying ideas of what is an acceptable wait time for patients. It is difficult to find examples in the literature quantifying the wait time that is tolerated in different patient populations in various types of healthcare settings. One study found that patients who arrive on time for an outpatient appointment are satisfied with a wait time of 37 minutes or less[27].

Queueing Theory

The theoretical foundation for studying lines of patients is Queueing Theory, an area of operations research. A queueing system consists of arriving customers that may or may not have to wait in one or more queues to see one or more servers providing services to these customers[28]. Queueing systems can be described by three components: the arrival process (rate and distribution), the service process (number of servers, whether their queues are separate or combined, their service times and distributions), and the queueing discipline (how a server chooses the next customer after each completed service)[28]. Basic queueing theory says that the fraction of time the clinician is being utilized (P) is equal to the rate of arrival of patients (Y) divided by the number of clinicians (C) multiplied by the rate at which a clinician can see patients (U), thus $P = Y/(C \times U)$[29]. Other performance measures can be derived from this basic relationship, such as the queue length and average wait time, and the effects of varying system parameters can be investigated [29]. However, it is rarely possible to find a closed-form, analytic solution to any but the very simplest situations being studied[30]. Given the complexity of the queueing process under consideration in this analysis, it was decided instead to build a discrete event simulation (DES) model to evaluate this system numerically.

Discrete-Event Simulation Modeling

DES can model complex systems involving patient processes in which queues may form for service[28]. It offers a systematic method to study a system's performance with varying inputs and to compare alternative approaches without high financial, personal, and customer costs[31]. DES has been used to assess various healthcare operations[32]. For instance, it has been used to evaluate resource allocation in operating rooms[33,34], processes, staffing and team composition in EDs[34-37], patient flow and scheduling in ultrasound and nuclear medicine services[38,39], bed-reservation schemes in an ICU[40], and the capacity and efficiency of providers in an outpatient clinic[41]. Some studies have shown the results of DES modeling can lead to more efficient use of medical resources, improved provision of services, and reduced wait times[39,42,43]. One group has used DES to identify possible improvements in staffing to increase the number of patients seen during clinic hours in an integrated VA primary care-mental health clinic[44].

Methods

Overview of Simulation Modeling Process

The major steps in the simulation modeling process were 1) gathering a description of the clinic setting, 2) developing assumptions, 3) building the DES model, 4) identifying the different scenarios, 5) running the scenarios and collecting the results, and 6) analyzing the results to compare the choices outlined.

I) Description of Clinic Setting

The model in this project is based upon the most integrated of the healthcare centers in Connecticut that this author interviewed for her summer internship program in 2013. This clinic is already moderately integrated, but it wants to increase its level of integration further. This center provides primary care services in multiple health centers and it serves mainly medically underserved patients from a low-income and predominantly minority population. The center's main payer source is Medicaid, but there are also a significant number of uninsured clients.

In this health center's clinics, the PCPs and BHPs work alongside one another. The BHPs see regularly scheduled behavioral health patients, but they have some time each day open to see patients who are referred by the PCPs with new or acute behavioral health problems. The clinics are attempting to see these patients on the same day, but not necessarily at the same time, that they are identified. Even so, I will refer to all these appointments as "warm-hand off" (WHO) appointments. The clinics range in size and, across the sites, the ratio of PCPs to BHPs ranges from 0.6 to 3.0.

Meetings were held with staff from the center to understand the flow of patients in their clinics. When a new or acute (but stable) behavioral health issue is identified, the PCP first asks the patient if he/she would like to be seen by a BHP. If so, the PCP uses instant messaging to alert an office staff member to schedule the patient for the next open WHO slot available in the BHPs' schedules. The patient is referred to the office staff at the end of the appointment to discuss the next available WHO appointment. The PCP also sends a referral through the electronic health record to the BHP explaining the reason for the WHO. This may be done in person if the providers meet in the clinic. If the patient is not able to come to the next open WHO slot that day, other open WHO slots on the same day are offered. If the patent is not able to come to any of the same-day WHO appointments, then open WHO slots on the next day are offered. If the patient can't come to any of those, he/she is given the phone number for the behavioral health department and asked to schedule an intake appointment in the future. Very acute and unstable behavioral health issues requiring immediate attention are handled differently and are not the focus of this project.

The center's staff also explained the process for the BHPs. The BHPs that are available to meet WHO patients also have a regular schedule of behavioral health patients. Every day these BHPs have one 90-minute slot for a psychotherapy group, one 60-minute slot for a new patient intake, four 45-minute slots for psychotherapy, and three 30-minute slots for counseling. These scheduled appointments do not occur at the same times each day; each BHP's daily schedule is a random assortment of these appointments, with every possible combination being equally likely.

In addition to the previously scheduled appointments above, each BHP that is available to assess WHO patients has three open 30-minute time slots ("open WHO slots") in order to see same-day behavioral health problems coming from primary care. When the clinic schedule was reviewed, it was seen that the open WHO slots occur randomly in the BHPs' schedules.

II) Developing Assumptions

A) This model assumes that efforts are made to have WHO patients seen by a BHP on the same-day rather than letting them leave unattended because it may improve engagement with treatment and follow-up at subsequent behavioral health appointments.

B) If WHO patients see a queue length of 6 patients or more, they will balk and not wait for a WHO appointment. Both scheduled patients and WHO patients will renege and leave the clinic after 1 hour waiting in a queue to see a BHP.

C) The rate of WHO patients referred from primary care is likely related to the prevalence of behavioral health problems in a clinic's population. The baseline prevalence of behavioral health disorders is not known for the center being modeled. However, this author, as part of a practicum project, conducted a survey of the center's PCPs. In this survey, the PCPs reported encountering four new behavioral health problems on an average clinical day (unpublished data). Thus, in this project, it is assumed that the PCPs are referring all the new or acute behavioral health problems that they encounter and that there will be on average four of them per PCP per day. Because this is an average arrival rate, on any given day, there may be more or fewer than four WHO patients being referred per PCP.

III) Building the DES Model

Computer Software

This model was built using ExtendSim 9.0 computer software available from Imagine That, Inc. in San Jose, CA. This software has the capacity to build complex discrete event models.

Parameters of the Model

1) Rate of Patient Arrivals

There are two relevant arrival rates/distributions in this model.

Scheduled Patients: The arrival rate of scheduled patients is based on the description above. For each BHP, a schedule is generated each day that contains a random assortment of one 90-minute, one 60-minute, four 45-minute, and two 30-minute appointment slots, with three open 30-minute slots for WHO appointments. Scheduled patients arrive according to this daily schedule. The option of having all five (rather than only three) of the 30-minute appointments open is also explored.

WHO Patients: The arrival rate of WHO patients is assumed to be Poisson, which means the WHO patients have exponentially distributed inter-arrival times. These can be summarized by an average number of arrivals per period of time. It seems reasonable to assume a Poisson distribution because each event of identifying a new or acute behavioral health issue in primary care and referring to a BHP is independent of all the others and fairly low frequency. The model can simulate many average arrival rates of WHO appointments. However, it is assumed that an average of four WHO patients are referred per day per PCP. Thus four average arrival rates, of 4, 8, 12, or 16 WHO patients per day, are modeled, corresponding to the four clinic sizes with 1, 2, 3, or 4 PCPs. Because these are average arrival rates, on any given day, there may be more or fewer than these numbers of WHO patients being referred from primary care.

2) Service (BHP) Organization

Number of Servers: There are between 1 and 4 full-time BHPs. Each of these BHPs has the daily schedule that is described above.

Service Time: A patient is seen for a service time that is described by the type of appointment (i.e. 90, 60, 45 or 30 minutes).

Organization of Queues: This model simulates one waiting room in which all patients, both scheduled patients and WHO patients, wait to be seen by BHPs. The scheduled patients wait for separate BHPs. In other words, **e**ach BHP has his/her own queue of scheduled patients, independent of other queues of scheduled patients waiting for other BHPs. The WHO patients wait to be seen by any of the BHPs, and thus are in a combined queue of all the queues for any of the BHPs, along with all scheduled patients and all WHO patients. Therefore, the WHO patients are making the decision of whether to balk or not based on seeing all the scheduled and WHO patients in the waiting room at the time of being referred.

3) Number of Open Slots for WHO appointments

There can be either three or five open 30-minute slots for WHO appointments in each BHP's daily schedule.

4) Queue Discipline

Model 1: WHO Patients have Priority

The WHO patients have priority and are seen by the BHP right after the current appointment. The already scheduled patients have to wait until after any waiting WHO patients are seen.

Model 2: Scheduled Patients have Priority

The previously scheduled patients have priority and are seen according to their scheduled time. The WHO patients have to wait until the BHP's next open WHO slot.

Analysis

Independent Variables/Scenarios Examined

This project analyzes the interaction of 3 main variables:

1) Four clinic sizes (1 PCP and 1 BHP, 2 PCPs and 2 BHPs, 3 PCPs and 3 BHPs, 4 PCPs and 4 BHPs, with corresponding average rates of WHO arrivals: 4, 8 12, and 16 WHO patients per day).
2) Two queue disciplines – WHO patients or scheduled patients have priority.
3) Two possible numbers of open WHO slots in the BHPs' daily schedule – 3 or 5 open slots.

The sixteen total combinations of these variables are shown in Table 1 in Appendix 1.

Outcome Variables:

The three main outcome variables analyzed are the percent of schedule patients served, the percent of WHO patients served, and the percent of BHP utilization. Other variables collected include the number of scheduled patients per day, the number of WHO patients per day, the number of scheduled patients that receive services, the number of WHO patients that receive services, the average wait time for a scheduled patient, and the average wait time for a WHO patient. The main outcome variables were chosen because these performance measures would seem to be the most salient to a clinical director planning operations. Also, two of the main outcome variables (percent of schedule patients served and percent WHO patients served) are likely to respond in opposite directions based on the queue discipline and number of open WHO slots chosen. Therefore, these measures will likely provide information as to the trade-offs that result from the different policy choices. In addition, the other outcome measures collected seem to be intermediate and determine the main outcome variables. Resource allocation or relative costs are not factored into this model.

Model Run Parameters

The length of one run was 480 minutes, a traditional 8-hour workday. For each scenario, the model was run 1000 times. This was an arbitrary decision, however, the model was tested for different numbers of runs and it was noted that, at 1000 runs, the average number of WHOs created converged on the number that was desired in each scenario with a stable and very small standard error. The output variables collected were the multi-run averages. A screenshot of one version of this DES model using ExtendSim is in Appendix 2.

Results

Figures 1 to 8 in Appendix 3 contain results for all 16 scenarios. Figures 1, 3, 5, and 7 show results for the four clinic sizes when WHO patients have priority. Figures 2, 4, 6, and 8 show results for the four clinic sizes when scheduled patients have priority. The three main outcome variables (percent of scheduled patients served, percent of WHO patients served, and percent of BHP utilization) are presented in each bar graph. The red bars show the outcomes when there are 3 open WHO slots and the blue bars show the outcomes when there are 5 open WHO slots. Table 2 in Appendix 4 displays the simulation results of all outcome variables for the 16 scenarios, organized by clinic size and then by queue discipline and number of open WHO slots.

The results from clinics with 1 PCP and 1 BHP in Figures 1 and 2, also shown on page 15, will be discussed first. Regarding the queue discipline, when WHO patients are given priority, the percent of WHO patients served is 80.6% and 81.0% and the percent of scheduled patients served is 84.4% and 86.6%, for 3 and 5 open slots respectively. When scheduled patients are given priority, the percent of scheduled patients served increases to 97.8% and 98.1%, but the percent of WHO patients served declines to 32.0% and 47.9%, for 3 and 5 open slots respectively. This pattern does not change much for larger clinic sizes, although the percent of WHO patients served for 3 and 5 open slots does rise with each increase in clinic size.

Considering the choice between 3 or 5 slots, when the queue discipline gives priority to WHO patients, there is little difference in the percent of scheduled patients served (84.4% and 86.6%) and the percent of WHO patients served (80.6% and 81.0%), which holds across the clinic sizes. When scheduled patients are given priority, changing from 3 to 5 open WHO slots increases the percent of WHO patients served by 15.7 percentage points (32.0% to 47.9%); this effect increases (19.2 , 20.3, and 20.7 percentage points) as the clinics get larger. In either queue

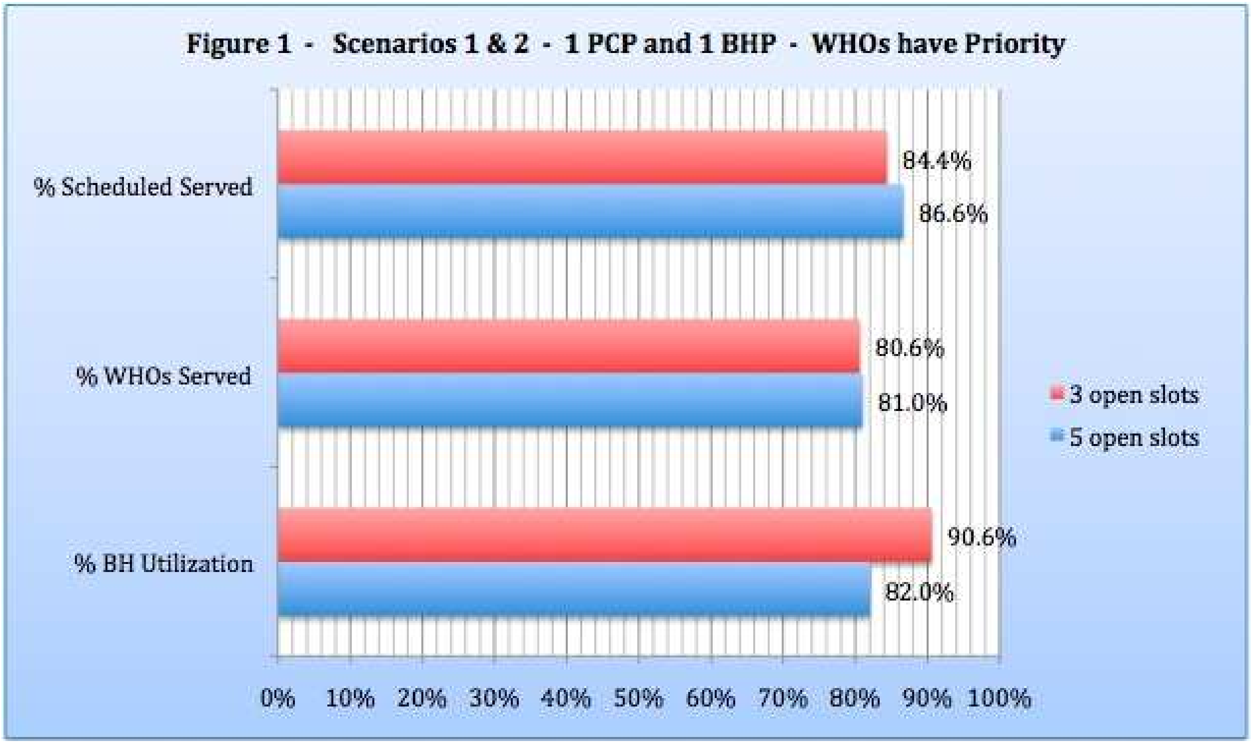
Figure 1 - Scenarios 1 & 2 - 1 PCP and 1 BHP - WHOs have Priority
% Scheduled Served
% WHOs Served
% BH Utilization
84.4%
86.6%
80.6%
81.0%
90.6%
82.0%
3 open slots
5 open slots
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

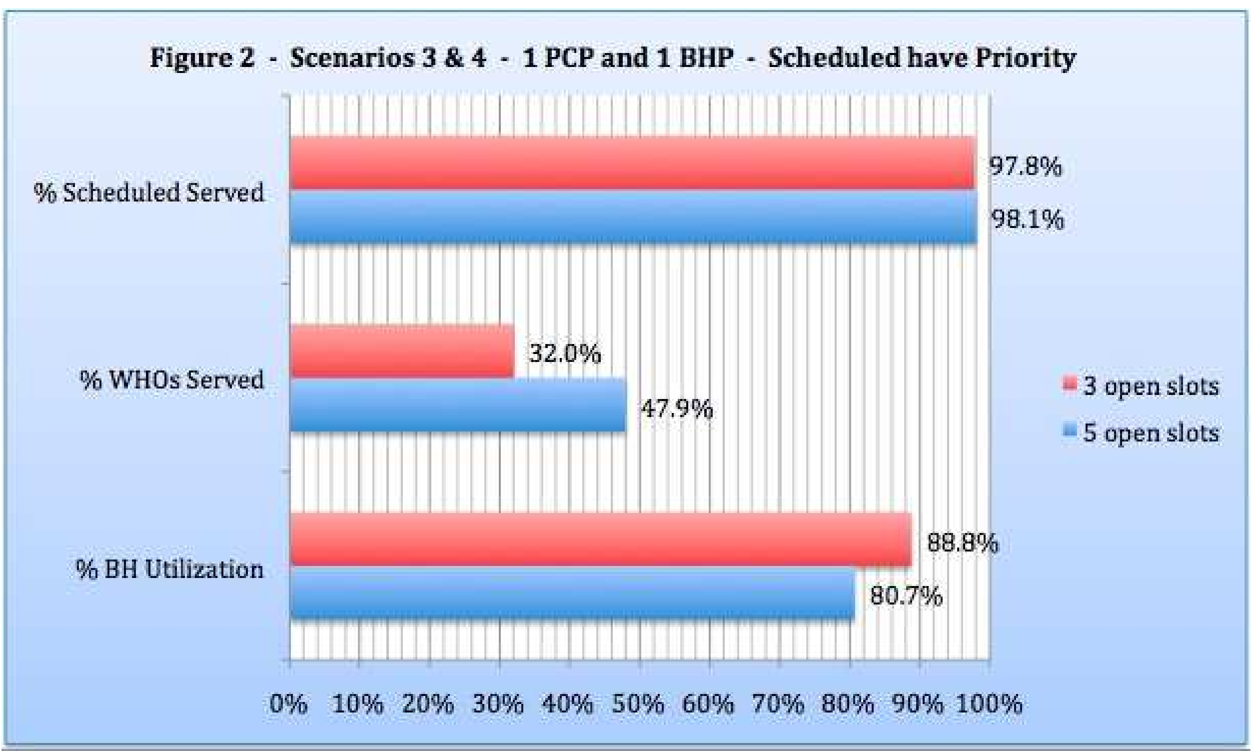
Figure 2 - Scenarios 3 & 4 - 1 PCP and 1 BHP - Scheduled have Priority
% Scheduled Served
% WHOs Served
% BH Utilization
97.8%
98.1%
32.0%
47.9%
88.8%
80.7%
3 open slots
5 open slots
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

discipline, changing from 3 to 5 open slots reduces the percent of BHP utilization by approximately 8 percentage points (90.6% to 82.0% when WHOs patients have priority and 88.8% to 80.7% when scheduled patients have priority), and a similar effect continues to be seen as the clinics become larger.

Increasing the size of the clinic, from 1 PCP and 1 BHP to 2 PCPs and 2 BHPs effects the percent of WHO patients served. When the queue discipline gives priority to WHO patients, the percent of WHO patients served increases from 80.6% and 81.0% to 90.3% and 90.3%, for 3 and 5 open slots respectively, with little additional improvement from successively larger increases in clinic size. When the queue discipline gives priority to the scheduled patients, the percent of WHO patients served increases from 32.0% and 47.9% to 45.2% and 64.4%, for 3 and 5 open slots respectively, and each successive increase in clinic size increases the percent of WHO patients served for both 3 and 5 open slots.

Table 2 in Appendix 4 also shows that, when the queue discipline changes from giving priority to scheduled patients to giving priority to WHO patients, for both 3 and 5 open slots, the average wait time for the scheduled patients increases from approximately 2-3 minutes to approximately 13-15 minutes. A similar change is seen across the clinic sizes.

Discussion

This project made use of DES computer software to build a model of a moderately integrated clinic and to simulate the flow of same-day WHO patients from primary care into a more traditional behavioral health service where the BHPs are also continuing to see regularly scheduled patients. This simulation was undertaken to investigate three main questions: what are the effects on the percent of scheduled patients served, the percent of WHO patients served, and percent of BHP utilization when the queue discipline changes from giving priority to scheduled patients to giving priority to WHO patients and when the number of open slots in the BHP's schedules are varied from 3 to 5. Plus, whether the clinic's efficiency changes with increasing clinic size was examined. All 16 scenarios explored in this simulation have 1:1 ratios of PCPs to BHPs, but the clinics range in size from 1 PCP and 1 BHP up to 4 PCPs and 4 BHPs.

The results of the 16 scenarios examined show that there is only a relatively small decrease in the percent of scheduled patients served compared to the large increase in the percent of WHO patients served when the queue discipline changes from giving priority to scheduled patients to giving priority to WHO patients. Plus, when WHO patients have priority, the average wait time for scheduled patients only increases from a few minutes to 13-19 minutes. These results appear to be robust across the four clinic sizes studied. Based on these results, clinics attempting to merge primary care and traditional behavioral health services, in which BHPs continue to also see regularly scheduled patients, might choose to give priority to WHO patients.

These clinics will encounter trade-offs in the choice between giving priority to already scheduled patients and giving priority to WHO patients. If a BHP sees a regularly scheduled patient and the WHO patient is asked to wait for the next open appointment, the WHO patient may balk or renege and leave the clinic without being seen. Likewise if the WHO patient is seen first in the next appointment and the regularly scheduled patient is asked to wait, the scheduled patient may leave without being seen. Importantly, there are costs associated with not treating either of these patient types. These costs may be diffuse and difficult to quantify, which will be discussed further below. However, the results of this simulation provide a framework to use when weighing up this choice.

Thus, for instance, consider clinics with 1 PCP and 1 BHP and 3 open WHO slots. Changing the queue discipline from giving priority to scheduled patients to giving priority to WHO patients increases the probability of being served from 32.0% to 80.6% for a WHO patient; at the same time, it decreases the probability of being served from 97.8% to 84.4% for a scheduled patient. Very generally, and all other things being equal, giving WHO patients priority is preferred so long as:

$$Cw / Cs > (97.8 - 84.4) / (80.6 - 32.0) \approx 1/3.6,$$

where Cw is the cost (or the disutility) associated with not seeing a WHO patient and Cs is the cost associated with not seeing a scheduled patient. The derivation of this formula is shown in Appendix 5. In other words, not seeing a scheduled patient would have to be 3.6 times worse than not seeing a WHO patient in order to opt to give priority to scheduled patients. This exercise was repeated for each pair of scenarios (same clinic size and number of open WHO slots) for the choice of queue discipline, and the results are shown in Table 3, Appendix 6. These results suggest that when comparing the choice in queue discipline between similar pairs of scenarios, the cost of not seeing a scheduled patient would have to be between approximately 2 and 4 times worse than not seeing a WHO patient in order to make the choice to give scheduled patients priority, at least across the scenarios examined here. It is important to remember that this simulation is based on assumptions that might vary in different clinics. What is important is the general idea that it is possible to inform decisions about a clinic's operating policies by weighing the relative magnitudes of the cost of not seeing scheduled patients versus the cost of not seeing WHO patients.

This project does not attempt to calculate the detailed costs associated with not seeing either patient type. In general though, the costs of not seeing a scheduled patient may include such things as lost revenue, a deterioration in the clinical relationship that could lead to a lack of engagement in treatment, possible worsening of the disorder and related health conditions, and worsening moral among the BHPs who don't like to ask scheduled patients to wait. The costs of not seeing a WHO patient may include worsening of the newly identified or acute disorder and related health conditions, a lack of engagement with behavioral health treatment, and worsening moral among PCPs who have to struggle to manage these patients on their own. In most instances, already scheduled patient visits will be paid for by some payer source. However, integrated services are not yet regularly reimbursed; there are some innovative financial arrangements that are paying for integrated services and in some states, certain Medicaid codes are activated that pay for integrated services, but these codes are not activated in all states[6,8]. Each clinic, depending on where they are located, the population served and the main payer sources will have different revenue trade-offs. However, the other costs are harder to quantify and may depend on the viewpoint of the person considering this choice.

There are likely many different perspectives on whether it is worse not to see a scheduled patient or not to see a WHO patient. CEO/CFOs of clinics, clinical directors, PCPs, BHPs, scheduled and WHO patients, and different stakeholders in society at large may all have different opinions. Some may argue that WHO patients are newly identified and acute and need to be introduced to a BHP very quickly or they may be lost to follow-up, thus $Cw >> Cs$. Alternatively, some may argue that revenue is all that matters. If a clinic gets the same reimbursement for either patient, it may mean $Cw = Cs$. However, other clinics may not get any reimbursement for WHO patients, in which case $Cw << Cs$. There are a variety of factors and many different views to consider in this decision.

The results of the DES simulation presented provide a more formal framework to help decision makers to weigh the costs of the trade-offs inherent in their choice of a queue discipline. It may lead clinics to consider more formally the costs associated with not seeing scheduled and WHO patients. Plus, it may help to put some perspective on the different options and show how much worse not seeing a schedule patient has to be in order to outweigh not seeing a WHO patient.

Considering the choice between 3 or 5 slots, when the WHO patients are given priority, the percent of scheduled patients served and the percent of WHO patients served remain stable, but are 5-10% different in all the scenarios. On the other hand, when scheduled patients are given priority, the percent of WHO patients served is much decreased with either 3 or 5 open slots. However, having 5 rather than 3 opens slots increased the percent of WHO patients served by over 15 percentage points and this grows as the clinics get bigger. Therefore, there are also tradeoffs in the choice of how many open slots to leave for WHO patients. Considering the scenarios with 1 PCP and 1 BHP and priority going to the WHO patients, when there are 3 open slots, 6.8 scheduled patients and 3.2 WHO patients are served. With 5 open slots, fewer scheduled patients (5.2) and only slightly more WHO patients (3.3) are served. Thus, the net gain or loss (the gain of serving 0.1 more WHO patient minus the cost of not serving 1.6 scheduled patients) of this choice needs to be weighed.

Furthermore, in all scenarios, moving from 3 to 5 open WHO slots resulted in slightly lower BHP utilization, which could reduce a clinic's efficiency. For example, in Figures 1 and 2, the percent BHP utilization decreases by approximately 8% when going from 3-5 slots, though it remained above 80%. This may result in a reduction of BHP revenue by 10 percent, with no decline in costs. This could mean a loss of profitability for some clinics. Therefore, in choosing between having 3 and 5 opens slots per BHP, there are trade-offs in the percent of each type of patient seen and the percent BHP utilization. Each clinic, depending on an analysis of the benefits and the costs of each of these tradeoffs, will have to decide which performance measure is most important.

For health centers that are attempting to integrate their primary care and traditional behavioral health services where BHPs are still seeing regularly scheduled patients, the results of this project appear to offer some support for giving WHO patients priority over scheduled patients. This could mean a change for traditionally run behavioral health departments that usually put a premium on starting appointments on time. Becoming more flexible with start times would require a shift in practice habit. It needs to be stressed again that this simulation is based on assumptions that could vary in different clinics. It is possible that, in this simulation, the degree of balking and reneging was underestimated and that even with the modest increase in wait times found, many more patients will balk or renege. However, the findings in this simulation do lend support to the view that the culture of behavioral health has to change if a goal is to accommodate more WHO referrals and facilitate integration with primary care. Changing the culture of behavioral health to adapt to working more integrally with primary care has been discussed before[17]. It may help to know that, when WHO patients were given priority, the average wait time for the scheduled patients only increased from a few minutes to 13-19 minutes across the scenarios. These wait times seem reasonable, given the evidence in the literature that patients arriving on time for their schedule appointments get dissatisfied after waiting 37 minutes[27]. However, in this project, the distribution of waiting times was not collected, and it would be important to see what percent of appointments were over 37 minutes.

Though a practice change in behavioral health may be needed to facilitate integration, it is not massive. This represents a “step-wise” transition that is discussed in the literature[5]. While there are already a few very integrated clinics with flexible BHPs who are trained to do treat behavioral health issues in primary care and now there are a few programs training BHPs to work in this manner, this is not the norm[18,19]. It is recognized that there is a workforce crisis for such BHPs[45]. Most centers still have more traditional behavioral health departments and most training programs for BHPs continue to teach a traditional model of treatment. This project offers a middle ground option to centers with traditional behavioral health departments that are attempting to integrate further. If clinics are already offering some BHP time to see WHO patients or are considering doing this, they could take a next-step and decide to give the WHO patients priority over scheduled patients. This will mean cultivating a culture change in both their BHPs and their patients. With BHPs this can be done by discussing the trade-offs and associated costs that are seen in this model, how to present this decision to scheduled patients when they are asked to wait, and also how BHPs can manage the stress that may arise when they need to accommodate a WHO and ask a scheduled patient to wait. In addition, patients can be educated to be more flexible about appointment times and to have more patience with wait times. Patients can be informed about this shift in clinic priorities and the reasons for it, and educated that appointment times are targets that may change if an acute patient needs to be seen first. At the time of being asked to wait, it may help if patients are informed about the average amount of time they will have to wait.

Giving priority to WHO patients resulted in approximately 20 percent of scheduled patients not seen, at least in the clinics with 1:1 ratios and the sizes examined. As many behavioral health clinics already have high no-show rates, some of the 20% of scheduled patients not seen under this queue discipline could possibly be accounted for by the patients already not showing up for appointments. If priority is given to WHO patients and the BHPs’ schedules become more flexible in response, the previously unused appointment times of the no-shows could possibly be used more flexibly to see WHO patients or scheduled patients who have been asked to wait.

Some Assumptions Explored Further

A number of assumptions are made in this paper that call for some discussion.

First, the average rate of WHO patients arriving from primary care may vary in different clinics. This model is based on a clinic serving a largely low-income population that may have a high burden of behavioral health issues. The assumed average rate of four WHO patients per PCP per day may not be accurate for centers serving different populations. Also, if and when clinics begin to do routine universal screenings for a wide range of behavioral health issues, the rate of new behavioral health problems identified in primary care could increase.

Second, this paper assumes that all the PCPs will identify and refer equal numbers of new and acute WHO patients. This may not be the case. Some PCPs are more comfortable identifying behavioral health problems than others, and thus may refer more often. At the same time, some PCPs may be more comfortable treating these issues themselves and may refer less often. In addition, some patients may be resistant to being referred to see a BHP for a WHO appointment. Similarly, some patients may have issues that make referrals difficult, such as language barriers.

Third, this model assumes that patients will wait for up to an hour before they renege and leave. Different populations may be more or less willing to wait depending on many factors, such as individual patience levels, the level of functioning of the population, the acuity of a patient's problem, how pleasant the wait is made, etc....Thus, this assumption is arbitrary. Clinics aiming to use models like the one in this project may want to investigate empirically how long their own patients will wait before leaving the clinic.

Fourth, it is assumed that the clinic in this model has no constraints on space. The PCPs and BHPs have their own rooms and there is no competition for space. This may be a real issue for some clinics. If one provider has to wait for another to finish using a room before seeing a patient, it may change the whole dynamic. Plus, it will have a bearing on the trade-off in costs of not seeing each type of patient. In DES modeling, spatial constraints can be built into the models and alternatives that take this into account can be investigated.

Limitations and Next Steps

There are a number of limitations in this project, some of which point the way to next steps.

First, this model only simulated four clinic sizes with a 1:1 ratio of PCPs to BHPs. It will be important to examine simulations of other clinic sizes and other ratios of PCPs to BHPs. In addition, this project only looked at 3 or 5 open WHO slots. Other possible numbers of open WHO slots could be analyzed. Also, the option of having one completely open BHP who is dedicated to seeing WHO patients, leaving other BHPs to see scheduled patients, is an option worth investigating.

Second, this project did not undertake to calculate the costs associated with not seeing scheduled and WHO patients. For many clinics, providing a detailed example of these costs, even for a hypothetical clinic, would be beneficial. In addition, the costs of increasing wait times could also be explored. The distribution of the number of people who wait/leave based on waiting time could be used to more accurately calculate the trade-offs in different scenarios.

Conclusion

In this project, a discrete event simulation (DES) model was built of a moderately integrated clinic and simulations were run on four clinic sizes, each with a ratio of 1PCP to 1 BHP, while varying whether scheduled or WHO patients were given priority as well as the number (3 or 5) of open WHO slots. It was found that giving priority to WHO patients, with either 3 or 5 open slots, resulted in a much larger percent of WHO patients served but only a slightly smaller percent of scheduled patients served. If scheduled patients were given priority, the percent of scheduled patients served increased somewhat, but the percent of WHO patients served decreased dramatically, though with 5 open slots, the decrease was not as great as with 3 open slots. Across scenarios, having 5 open slots led to a slightly lower percent of BHP utilization than 3 open slots. When WHO patients were given priority, the average wait time for scheduled patients increased from a few minutes to only 13-19 minutes across clinic sizes. These results might lead some clinics attempting to integrate primary care and traditional behavioral health services to choose to give WHO patients priority. However, there are costs associated with not seeing both scheduled and WHO patients and the trade-off in these costs was explored very generally. It was shown that not seeing scheduled patients would have to be approximately 2-4 times worse than not seeing WHO patients, in the scenarios examined, for the scheduled patients to be given priority. If clinics do decide to give priority to WHO patients, this may not require a huge change. However, it will require a shift in the culture of traditional behavioral health services to become more flexible with appointment times.

Clinics trying to integrate further will have to weigh these tradeoffs for their own situations. The analysis here provides an example of one method that might assist in choosing between different arrangements of integration. This project only examined clinics with 1:1 ratios of PCPs to

BHPs for four clinic sizes. This, along with other limitations, restricts the generalizability of these findings to many real world clinics. However, this project shows the feasibility of building a DES model to investigate alternate versions of integration. With this type of software, it is possible to model an array of different clinic organizations and sizes and to examine the results of varying a number of parameters. Clinic leaders could build their own models, based on their clinics' organization, in order to compare alternatives that might assist in decisions about the next-steps to take to further integration.

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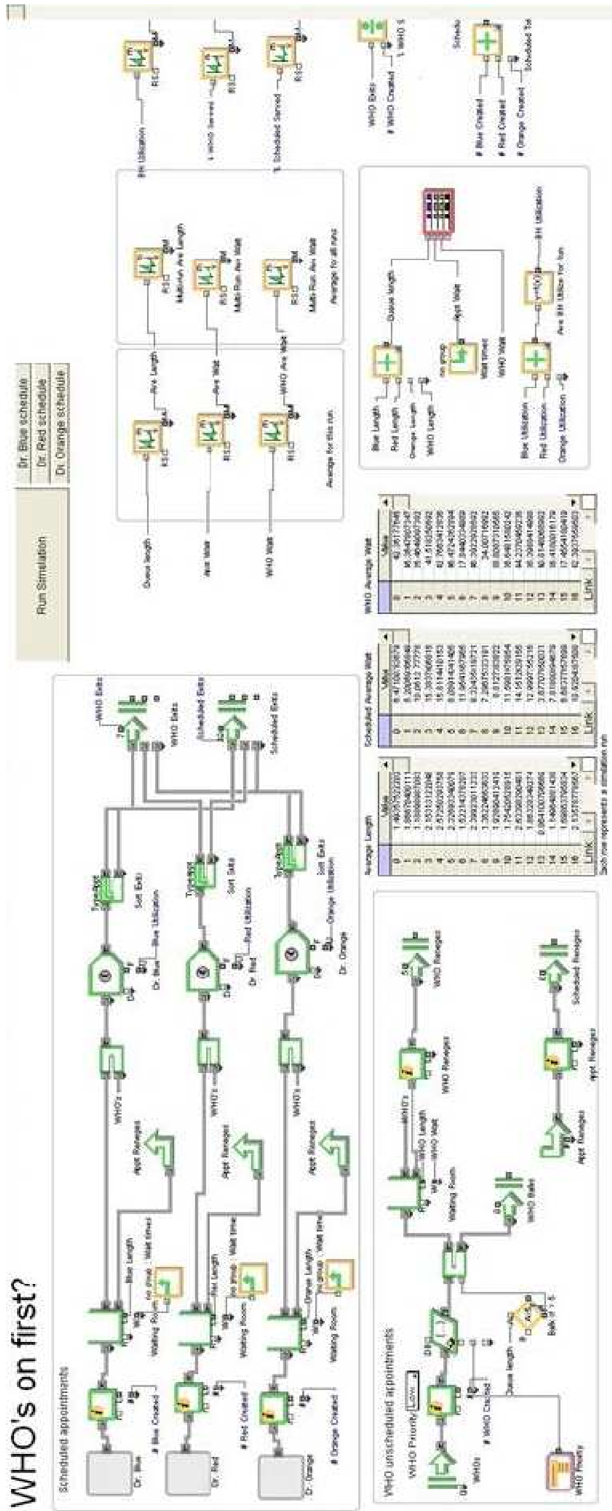
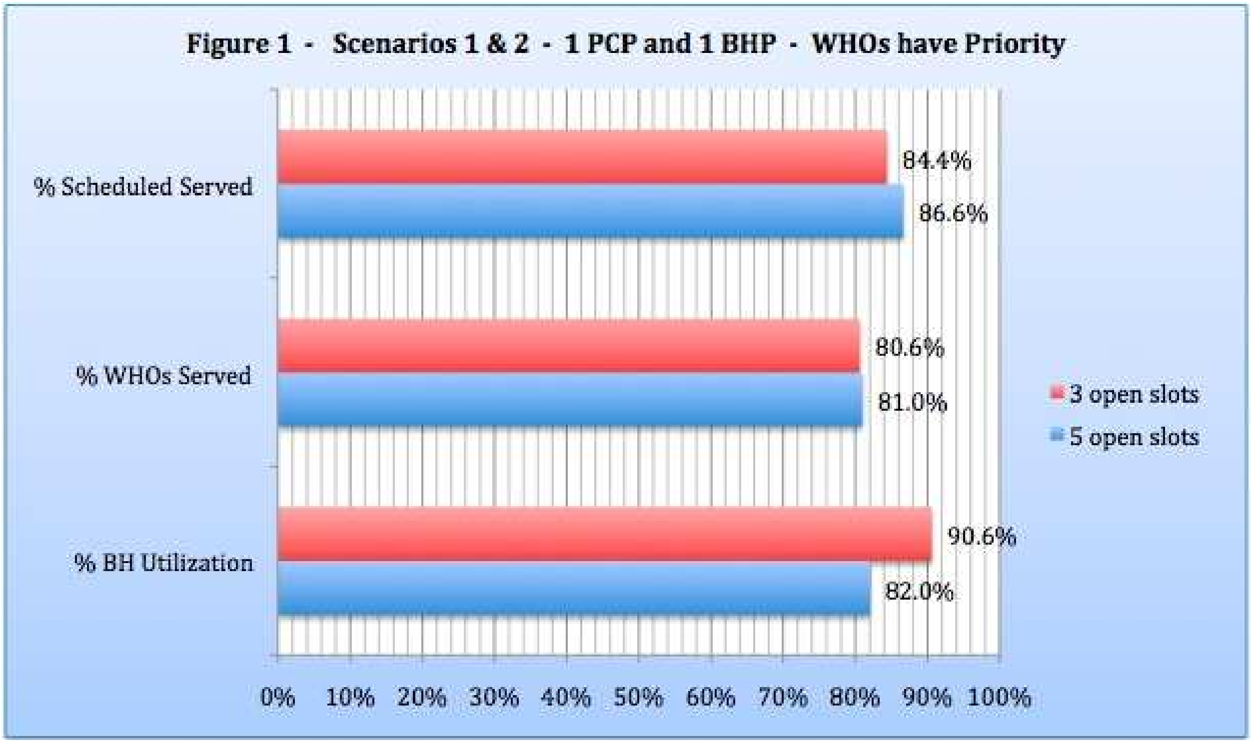
Appendix 1 -Table 1: All 16 Scenarios Analyzed

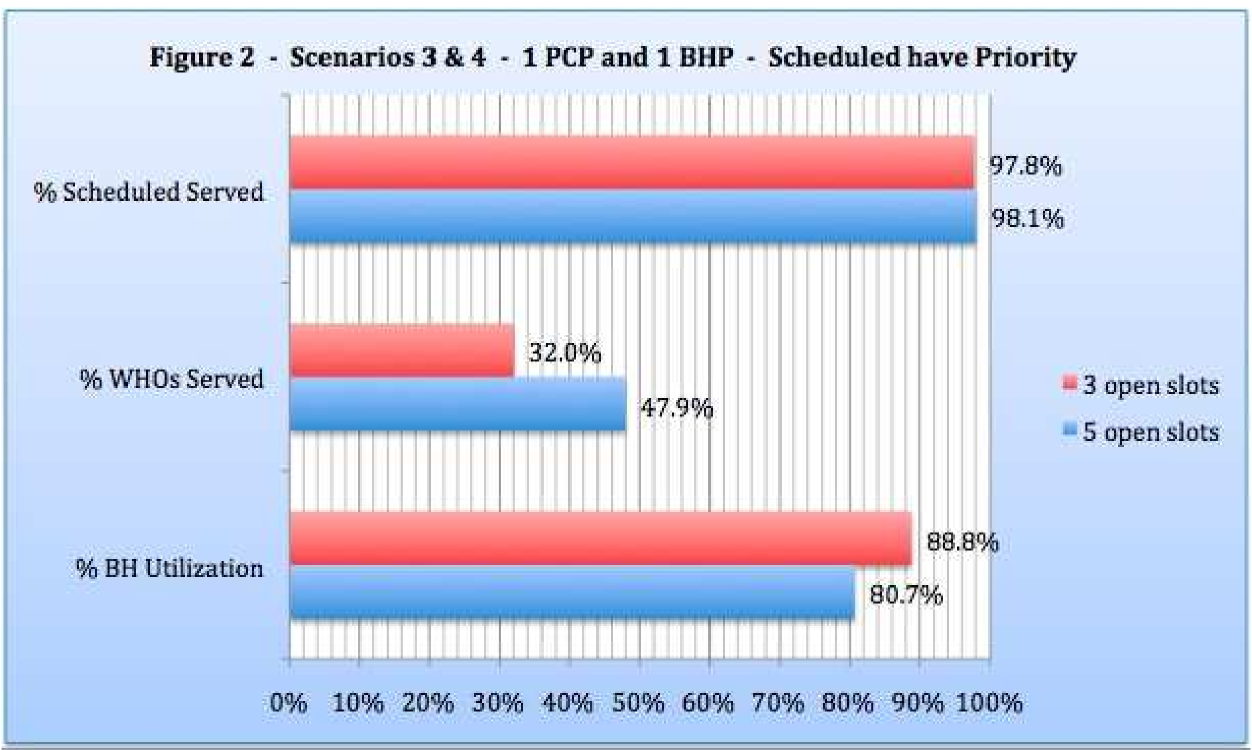
Table 1: 16 Scenarios	Ratio of PCPs to BHPs	Queue Discipline	Number of Open Slots
Scenario 1	1 to 1	WHO Priority	3
Scenario 2	1 to 1	WHO Priority	5
Scenario 3	1 to 1	Scheduled Priority	3
Scenario 4	1 to 1	Scheduled Priority	5
Scenario 5	2 to 2	WHO Priority	3
Scenario 6	2 to 2	WHO Priority	5
Scenario 7	2 to 2	Scheduled Priority	3
Scenario 8	2 to 2	Scheduled Priority	5
Scenario 9	3 to 3	WHO Priority	3
Scenario 10	3 to 3	WHO Priority	5
Scenario 11	3 to 3	Scheduled Priority	3
Scenario 12	3 to 3	Scheduled Priority	5
Scenario 13	4 to 4	WHO Priority	3
Scenario 14	4 to 4	WHO Priority	5
Scenario 15	4 to 4	Scheduled Priority	3
Scenario 16	4 to 4	Scheduled Priority	5

Appendix 2 – Screenshot of One Version of DES Model using ExtendSim

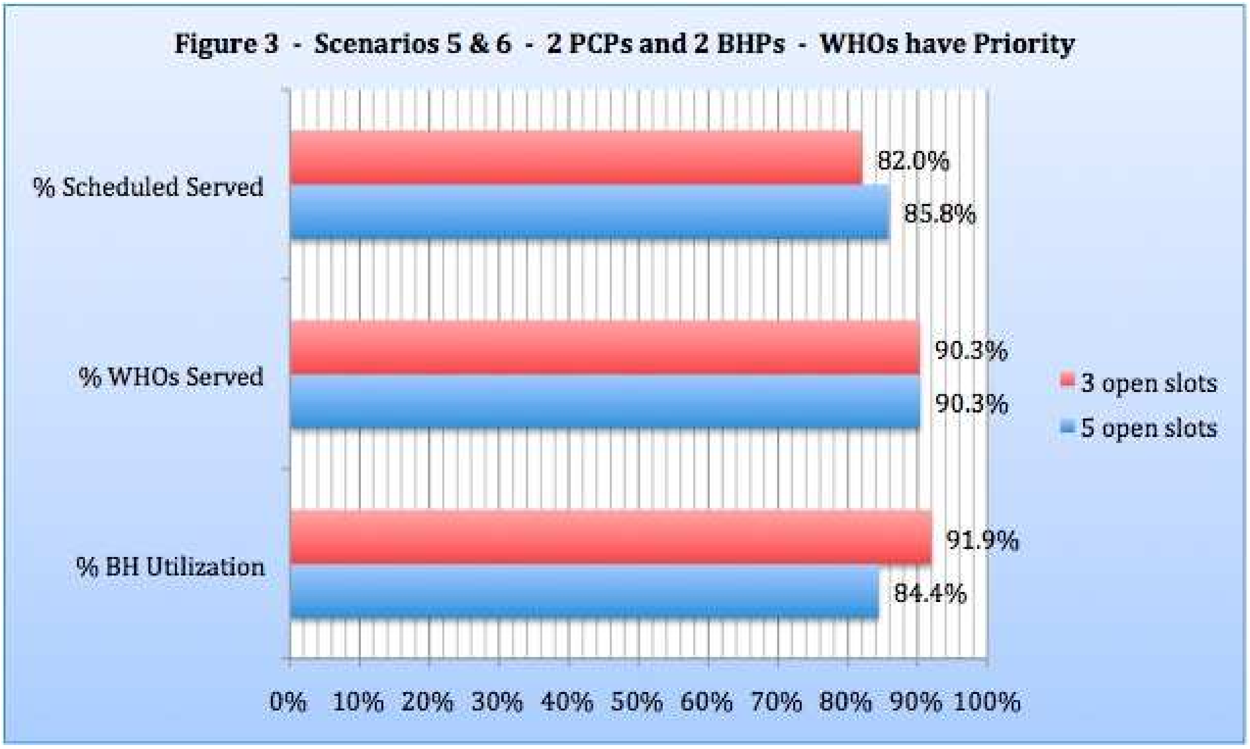


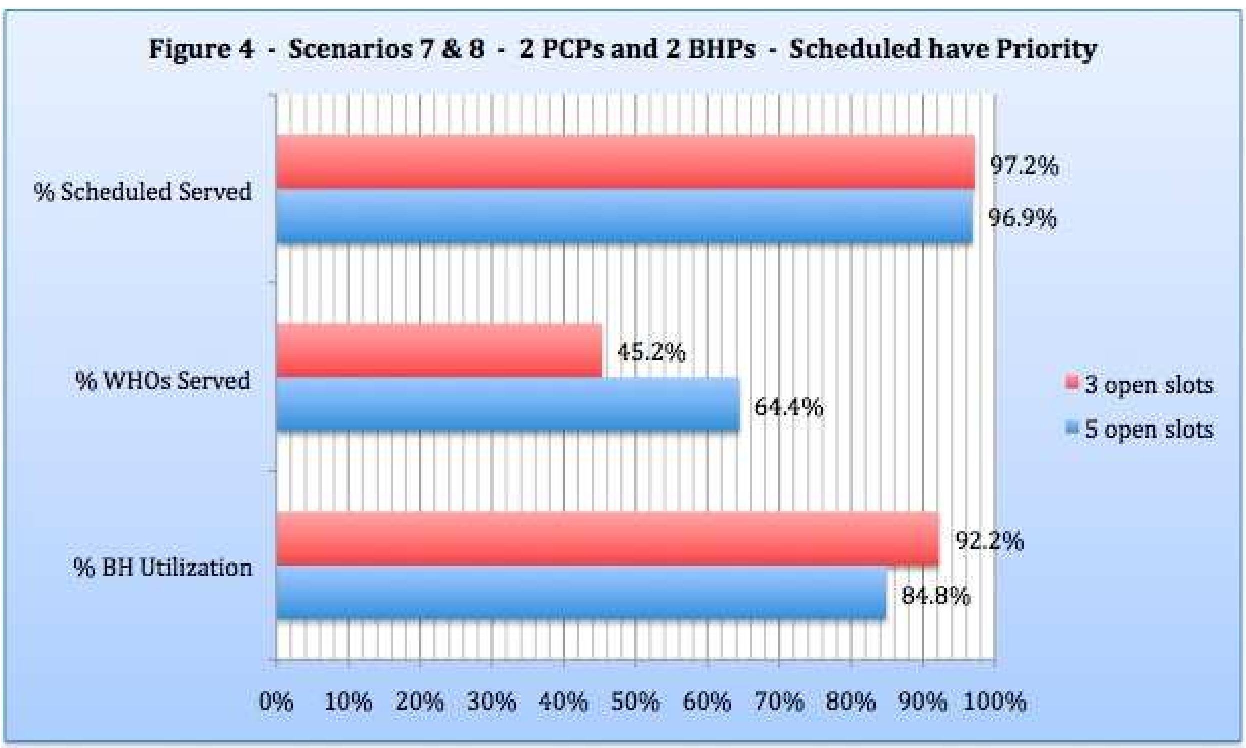
Appendix 3 - Figures 1-8: Main Outcome Variables by Clinic Size and Queue Discipline



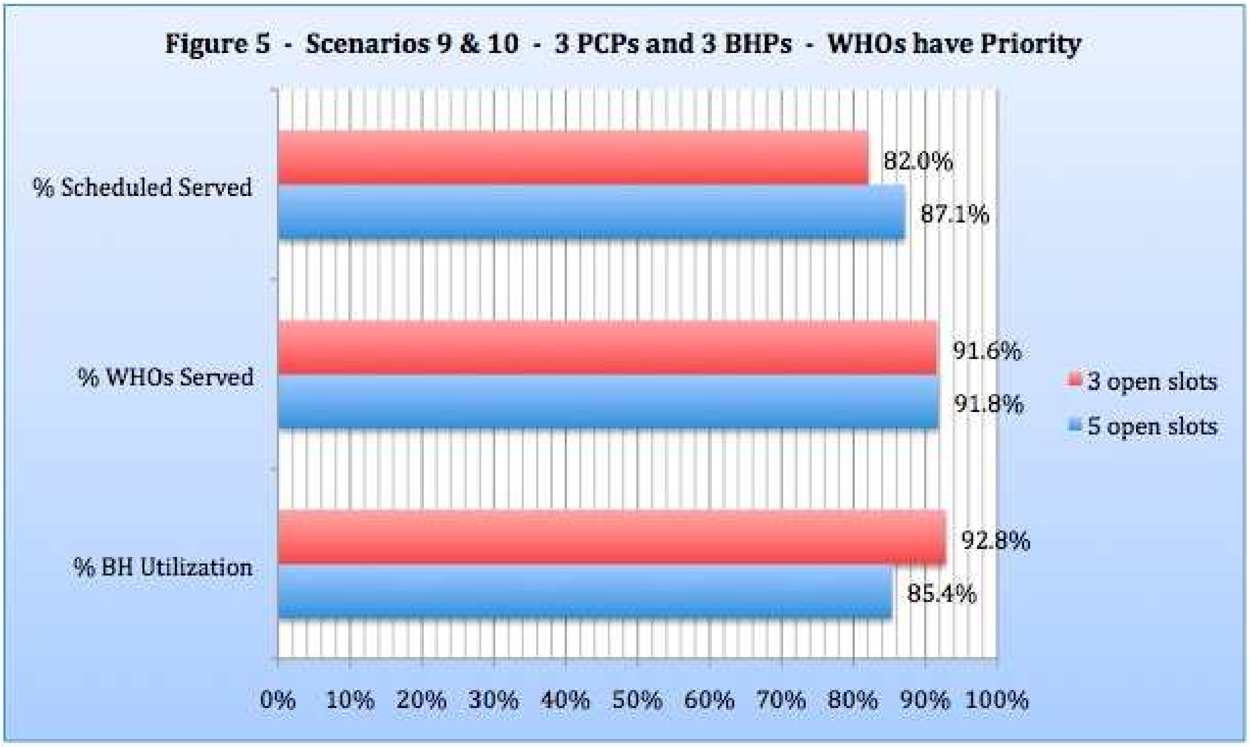


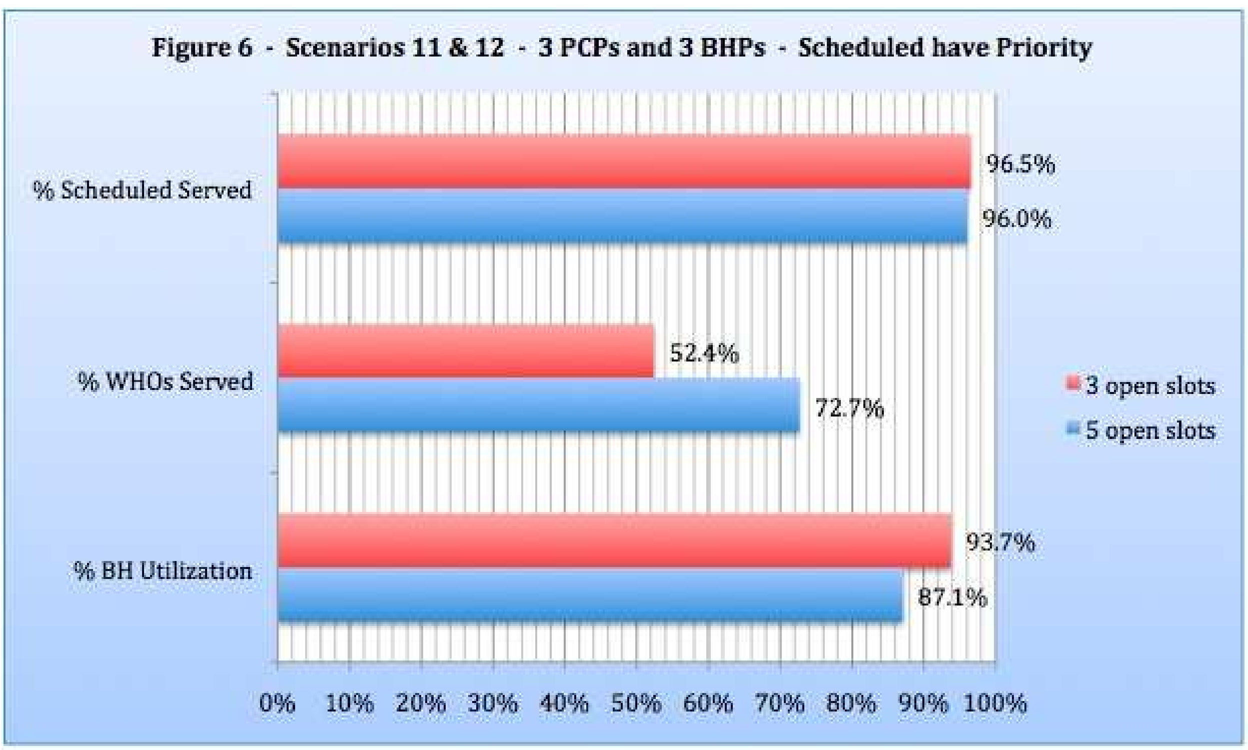
Appendix 3 continued



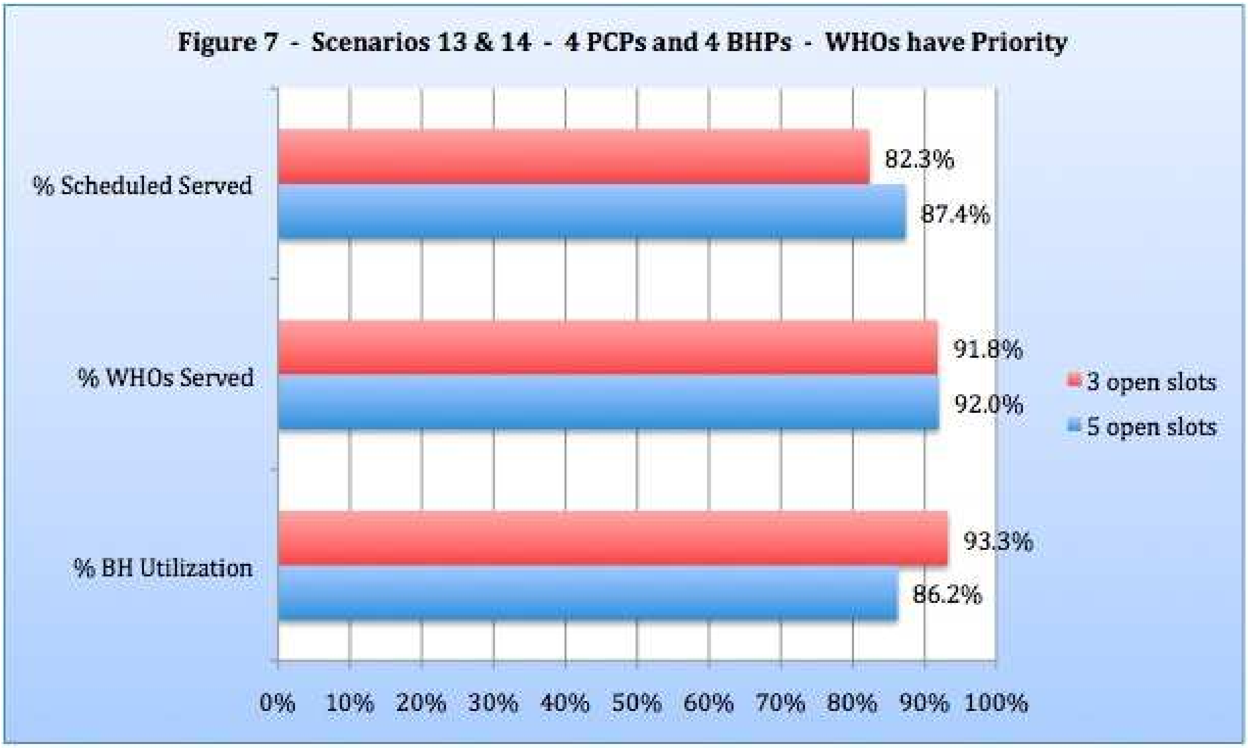


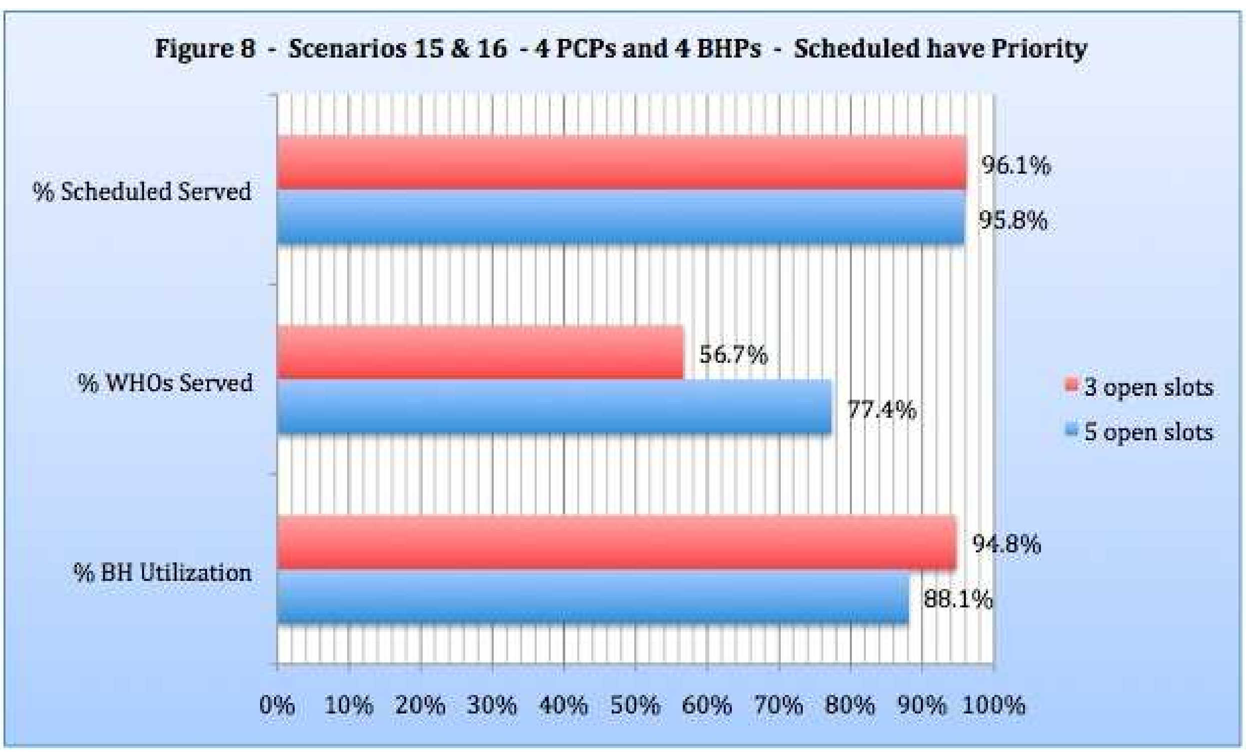
Appendix 3 continued





Appendix 3 continued





Appendix 4 - Table 2: All Outcome Data on the 16 Scenarios Analyzed

Table 2: All Outcome Data

1 PCP, 1 BHP	Total Scheduled Patients	Scheduled Patients Served	% Scheduled Patients Served	Average Scheduled Wait Time (mins)	Total VHO Arrivals	VHO Patients Served	% VHO Patients Served	Average VHO Wait Time (mins)	% BHP Utilization
VHO Priority, 3 slots	8	6.75	84.4%	15.62	3.92	3.16	80.6%	24.35	90.6%
VHO Priority, 5 slots	6	5.20	86.6%	13.30	4.05	3.28	81.0%	22.86	82.0%
Scheduled Priority, 3 slots	8	7.82	97.8%	2.13	3.96	1.27	32.0%	41.76	88.8%
Scheduled Priority, 5 slots	6	5.88	98.1%	2.73	3.98	1.91	47.9%	34.46	80.7%

2 PCPs, 2 BHPs	Total Scheduled Patients	Scheduled Patients Served	% Scheduled Patietns Served	Average Scheduled Wait Time (mins)	Total VHO Arrivals	VHOs Patients Served	% VHO Patients Served	Average VHO Wait Time (mins)	% BHP Utilization
VHO Priority, 3 slots	16	13.12	82.0%	17.92	7.97	7.20	90.3%	16.08	91.9%
VHO Priority, 5 slots	12	10.30	85.8%	14.80	8.15	7.36	90.3%	14.39	84.4%
Scheduled Priority, 3 slots	16	15.55	97.2%	3.32	8.06	3.65	45.2%	37.90	92.2%
Scheduled Priority, 5 slots	12	11.62	96.9%	3.85	8.06	5.19	64.4%	27.51	84.8%

3 PCPs, 3 BHPs	Total Scheduled Patients	Scheduled Patients Served	% Scheduled ·· ts Served	Average Scheduled Wait Time (mins)	Total VHO Arrivals	VHOs Patients Served	% VHO Patients Served	Average VHO Wait Time (mins)	% BHP Utilization
VHO Priority, 3 slots	24	19.69	82.0%	18.73	12.09	11.08	91.6%	11.65	92.8%
VHO Priority, 5 slots	18	15.69	87.1%	14.29	11.89	10.91	91.8%	9.76	85.4%
Scheduled Priority, 3 slots	24	23.16	96.5%	3.62	11.92	6.25	52.4%	35.32	93.7%
Scheduled Priority, 5 slots	18	17.28	96.0%	5.02	12.22	8.88	72.7%	23.77	87.1%

4 PCPs, 4 BHPs	Total Scheduled Patients	Scheduled Patients Served	% Scheduled Patients Served	Average Scheduled Wait Time (mins)	Total VHO Arrivals	VHOs Patients Served	% VHO Patients Served	Average VHO Wait Time (mins)	% BHP Utilization
VHO Priority, 3 slots	32	26.35	82.3%	18.65	16.14	14.82	91.8%	9.00	93.3%
VHO Priority, 5 slots	24	20.97	87.4%	14.62	16.08	14.79	92.0%	7.44	86.2%
Scheduled Priority, 3 slots	32	30.76	96.1%	3.89	15.88	9.00	56.7%	34.12	94.8%
Scheduled Priority, 5 slots	24	22.98	95.8%	5.21	16.17	12.51	77.4%	21.44	88.1%

Appendix 5 - The derivation of the formula for Cw /Cs

ECS = estimated cost when queue discipline gives priority to scheduled patients
ECW = estimated cost when queue discipline gives priority to WHO patients

Ps(S) = probability of serving a scheduled patient when scheduled patients have priority
Ps(W) = probability of serving a WHO patient when scheduled patients have priority
(1-Ps(S)) = probability of not serving a scheduled patient when scheduled patients have priority
(1-Ps(W)) = probability of not serving a WHO patient when scheduled patients have priority

Pw(S) = probability of serving a scheduled patient when WHO patients have priority
Pw(W) = probability of serving a WHO patient when WHO patients have priority
(1-Pw(S)) = probability of not serving a scheduled patient when WHO patients have priority
(1-Pw(W)) = probability of not serving a WHO patient when WHO patients have priority

Cs = cost of not serving a scheduled patient
Cw = cost of not serving a WHO patient

Therefore:

$$ECS = (1-Ps(S))(Cs) + (1-Ps(W))(Cw)$$
and
$$ECW = (1-Pw(S))(Cs) + (1-Pw(W))(Cw)$$

When these costs are equal:

$$(1-Ps(S))(Cs) + (1-Ps(W))(Cw) = (1-Pw(S))(Cs) + (1-Pw(W))(Cw)$$
so

$$((1-Ps(S)) -(1-Pw(S)))(Cs) = ((1-Pw(W))-(1-Ps(W)))(Cw)$$
so

$$(Pw(S)-Ps(S))(Cs) = (Ps(W)-Pw(W))(Cw)$$
thus:

$$Cw / Cs = (Pw(S)-Ps(S)) / (Ps(W)-Pw(W))$$
Or
$$Cw / Cs = (Ps(S)-Pw(S)) / (Pw(W)-Ps(W))$$

Appendix 6 - Table3: Results of Cw/Cs comparing same sized clinics with same number of open slots by queue discipline

Table 3: Cost of not seeing WHO/Cost of not seeing scheduled by queue discipline		
Comparing same sized clinics with same number open slots, but different queue discipline		
Scenarios being compared	**Formula** **Cw/Cs =**	**Outcome** **Cw/Cs =**
Scenarios 1 & 3	(97.8-84.4)/(80.6-32.0)	1/3.63
Scenarios 2 & 4	(98.1-86.6)/(81.0-47.9)	1/2.88
Scenarios 5 & 7	(97.2-82.0)/(90.3-45.2)	1/2.97
Scenarios 6 & 8	(96.9-85.8)/(90.3-64.4)	1/2.33
Scenarios 9 & 11	(96.6-82.0)/(91.6-52.4)	1/2.7
Scenarios 10 & 12	(96.0-87.1)/(91.8-72.7)	1/2.15
Scenarios 13 & 15	(96.1-82.3)/(91.8-56.7)	1/2.54
Scenarios 14 & 16	(95.8-87.4)/(92.0-77.4)	1/1.74