



Effect of an Online Appointment Scheduling System on Evaluation Metrics of Outpatient Scheduling System: a before-after Multicenter Study

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Abstract

Online appointment scheduling systems have been designed in response to the problems of the traditional ones. In Iran, most outpatient clinics and our study population suffer from high patient' no-show rate and long waiting times because of not using online appointment scheduling system. In this study, the effect of an online appointment scheduling system was investigated by comparing the evaluation metrics of appointment scheduling before and after the intervention. This before-after pilot study was conducted on ten outpatient clinics with different specializations. Five clinics were selected as the intervention group and five clinics as the control group. A checklist was designed to evaluate appointment scheduling metrics. These checklists were completed from April to July 2017 in the pre-implementation phase and from September to December 2017 in the post-implementation phase. The evaluation metrics were evaluated before and after the implementation of the online appointment scheduling system. A total of 470 checklists containing 9034 patients' information and 460 checklists containing 9130 patients' information were completed at the pre- and post-implementation phases, respectively. There were significant positive effect on the improvement of the three metrics means, including Patient waiting time (38.2 min before vs. 23.8 min after the intervention), No-show rate (25% before vs. 11% after the intervention), and Physician punctuality (-30 min before vs. -14.2 min after the intervention). The use of an online appointment scheduling system was successful in improving several evaluation metrics in our target population and resulted in continued usage in intervention group clinics.

Keywords Online appointment scheduling system · Evaluation metrics · Outpatient clinics

Background

Online appointment scheduling systems have been designed and implemented in response to the barriers and problems associated with the traditional ones [1, 2]. These systems with benefits such as taking appointment at the right time and date

with the intended physician and 24-h accessibility to the system have increased patient satisfaction [3–5]. Also, by reducing the patients waiting time and adjusting clinics capacity through reducing the number of phone calls, these systems have improved the quality of care and patients accessibility to outpatient services [6–9]. In many countries, these systems

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Table 1 Evaluation metrics used and their definition

No	Metrics	Definition
1	Patient waiting times	Subtract the greater of {appointment time, arrival time} from the service start-time [28]
2	Patient no-show rate	The number of no-shows divided by the sum of the number of no-shows and the total number of appointments kept [29]
3	Patient punctuality	The difference between a patient's appointment time and actual arrival time [28]
4	Physician punctuality	The difference between the first appointment time is given to the patient and the physician's arrival time [23]
5	Service times	The amount of time the physician spends with the patient [30]
6	Panel size	The number of patients covered by the physician [31]
7	Clinic size	The number of patients scheduled per clinic session [28]
8	Walk-in rate	The number of patients who walk in without appointments as a percentage of all appointments [28]

have recently been replaced in most private and outpatient clinics [7, 10, 11]. However, in Iran, most outpatient clinics available as well as our study population suffer from high patient' no-show rate and long waiting times due to the use of appointment scheduling based on phone call and in-person referral [12–14]. The lack of a proper referral system can also affect the occurrence of these problems [15]. In Iran the family doctor based referral system is currently being implemented for people living in villages and cities with a population of 20,000 or fewer and would be implemented soon for the whole cities [16]. In our study population, citizens are now free to visit each specialist and clinic and do not need to be referred by a general practitioner. Therefore, this situation causes congestion in many private and outpatient clinics [15, 17].

On the other hand according to the Communications Regulatory Authority (CRA) of Iran in 2018, broadband internet penetration rate was reported as 90.79% (fixed broadband internet penetration rate was reported as 12.65%, and mobile broadband internet penetration rate was reported as 78.14%). Also, the penetration rate of mobile phones was reported to be 113.34% ([https://](https://www.cra.ir/en/enhome)

www.cra.ir/en/enhome). Therefore, due to the easy access of all users to these systems, the need for applying online appointment scheduling systems is felt more than ever. There is no an interventional study conducted with the aims of implementing an online appointment scheduling system and eliminating problems associated with the appointment scheduling in outpatient sector in our target population. Therefore, in this study, the effect of an online appointment scheduling system was investigated by comparing the evaluation metrics of appointment scheduling before and after the intervention.

Methods

This before-after pilot study was conducted on ten outpatient clinics with different specializations in Mashhad, as the second largest city in Iran. The study was sponsored and approved by Mashhad University of Medical Sciences. The permission was obtained from the Ethics Committee ([IR.MUMS.fm.REC1395.312](https://www.cra.ir/en/enhome)).

Table 2 Specifications of the studied clinics

Medical clinic	Health care services offered	Clients	Clinic hours	Group
1	Diet therapy and nutritional counseling	Adults and children	4	Intervention
2	Neurosurgery, Sleep disorders management	Mostly adults or elderly people	4	Control
3	Ophthalmologic surgery, Pediatric ophthalmology, Strabismus correction	Adults and children	5	Control
4	Obstetrics and gynecology, prenatal consultation	expectant women or mothers with babies	5	Control
5	Optometry	Adults and children	3	Intervention
6	Pediatrics, Children Nutrition, Health and Development, Premature baby management	Infants and children	4	Control
7	Orthodontics	Adults and children	4	Intervention
8	Cardiac surgery, Pacemaker management, Holter monitoring, Echocardiogram and exercise testing	Mostly adults or elderly people	3	Intervention
9	Pediatrics and neonatology	Infants and children	3	Control
10	Cardiac surgery	Mostly adults or elderly people	4	Intervention

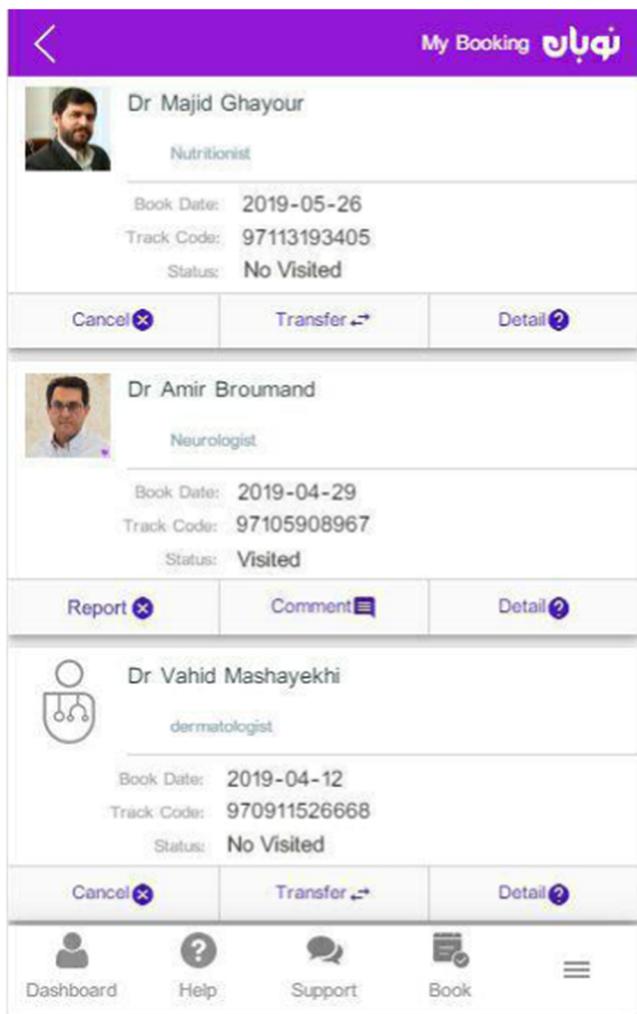
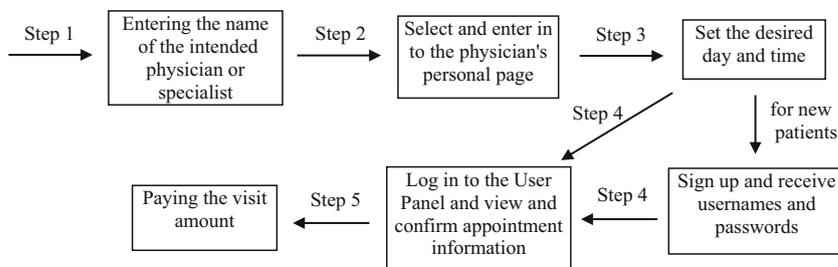


Fig. 1 The screenshot of the designed online appointment scheduling system

Assessment tools

The evaluation metrics used along with the definition of each are shown in Table 1. A checklist was designed to evaluate these metrics so that all metrics were measurable through the items included in this checklist (Appendix A). As the clinics secretaries were responsible for completing the checklists, the necessary training for completing the all checklist fields was given to them; in addition, it was tried to prevent from the occurrence of possible mistakes by visiting clinics daily and checking how the checklists are completed.

Fig. 2 The main steps of the appointment scheduling process



Participants

The study population consisted of ten private clinics selected from different specializations in Mashhad. The clinics were selected based on the available sampling method. From a total of ten clinics, five clinics were selected as the intervention group and five clinics as the control group to participate in this study. Clinics specifications are shown in Table 2. There was no an online appointment scheduling system in none of the ten clinics, where patients took appointment through in-person referral or phone call. In five intervention group clinics, an online appointment scheduling system was launched as an intervention. To this end, for each of the clinics secretaries, one tablet was prepared, on which a version of mobile appointment scheduling application was installed to enable the secretaries to manage appointments through the system admin panel while in the five control group clinics, as before, patients were given an appointment by telephone call or in-person referral.

Online appointment scheduling system

The online appointment scheduling system was designed and implemented very user friendly and secure. In this system, it was made use of clinics secretaries and physicians to give an appointment to patients and to manage appointments. It was possible to communicate with the system through the website, mobile app., and *interactive voice response (IVR)*. The website was designed in PHP (Hypertext Preprocessor) language; this website was accessible through the <https://nobaan.com> domain. MYSQL was used to manage the database. The mobile app. Was developed for both iOS and Android operating systems (OS). It was also installable on tablets running Android OS. Figure 1 shows the screenshot of the designed online appointment scheduling system. In addition to the main processes, in this system, there were facilities such as question-answer communication between patient and physician in order to improve the communication between the two, clinic location guidance for on time accessibility, patient survey, and reminding appointment time to patient.

Table 3 Evaluation metrics before and after the intervention in the five intervention group clinics

Metrics	Before	After	P value
Patient Waiting time (Minutes)	38.2	23.8	.043
Service time (Minutes)	9.6	10.6	.102
Patient Punctuality (Minutes)	1.4	1.8	.686
No-Show Rate (%)	25	11	.043
Walk-in Rate (%)	20	15	.078
Clinic Size (n)	20.8	16.6	.104
Panel Size (n)	17.8	17.6	.783
Physician Punctuality (Minutes)	- 30	- 14.2	.043

Evaluation process

According to the type of research, the intended metrics (Table 1) were evaluated before and after the implementation of the online appointment scheduling system. For this purpose, designed checklists were distributed in the ten clinics under study to evaluate these metrics. These checklists were completed manually by the clinics secretaries as assessors from April to July 2017 for three months in the pre-implementation phase and from September to December 2017 for three months in the post-implementation phase. During this six-month period, information about all patients referred to these clinics was recorded in the checklists. Then, the results of the pre- and post-implementation phases were compared to each other to evaluate the effectiveness of the online appointment scheduling system.

On the other hand, to prevent from the system failure and sudden shift in the clinics workflow, by physicians' agreement, a certain time period of each clinic working day was allocated exclusively to the online appointment scheduling system. During the rest of the clinics working hours, patients set appointments by in-person referral or phone call. The interval was changed based on physicians' satisfaction or dissatisfaction.

Table 4 Evaluation metrics before and after the intervention in the five control group clinics

Metrics	Before	After	P value
Patient Waiting time (Minutes)	34.8	37.6	.131
Service time (Minutes)	10.8	10.4	.157
Patient Punctuality (Minutes)	- 7.4	- 3.6	.109
No-Show Rate (%)	14	14	1.000
Walk-in Rate (%)	16	17	.109
Clinic Size (n)	21.2	22.4	.102
Panel Size (n)	22.2	23.8	.059
Physician Punctuality (Minutes)	- 29	- 32.4	.465

Table 5 Mean difference of all metrics in the two groups before and after the intervention

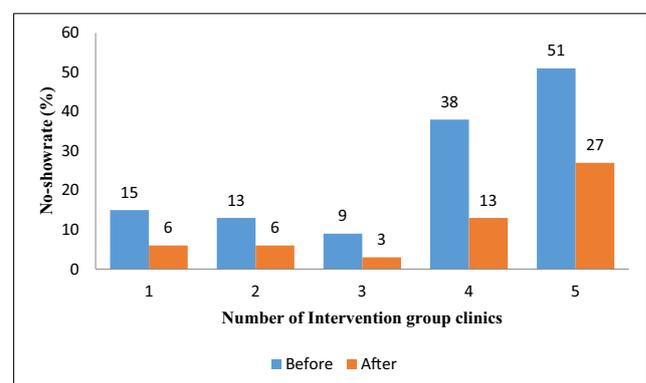
Metrics	Intervention	Control	P value
Patient Waiting time (Minutes)	14.4 ± 5.9	- 2.8 ± 4.3	.008
Service time (Minutes)	- 1 ± 1	0.4 ± 0.5	.056
Patient Punctuality (Minutes)	- 0.4 ± 17.5	- 3.8 ± 3.6	.31
No-Show Rate (%)	14 ± 0.1	0 ± 0.1	.008
Walk-in Rate (%)	5 ± 0.1	- 1 ± 0.1	.052
Clinic Size (n)	4.2 ± 5.1	- 1.2 ± 1.6	.056
Panel Size (n)	0.2 ± 2.3	- 1.6 ± 1.9	.22
Physician Punctuality (Minutes)	- 15.8 ± 13.9	3.4 ± 7.8	.016

In order to introduce the online appointment scheduling system to patients, two methods were used in all the intervention group 5 clinics. Initially, an appointment scheduling manual was distributed. Then a video clip was designed to familiarize patients with the main stages of the online appointment scheduling process and distributed.

The main steps of the appointment scheduling process are identical on both the website and the mobile app (Fig. 2). At the end of the process, appointment information is sent to the patient via SMS.

Analysis of data

After collecting completed checklists, data in checklists were entered into SPSS software to calculate the intended evaluation metrics. SPSS software version 20 was used to analyze the data with a confidence level of 95% and significance level of .05. Kolmogorov-smirnov test was used to test the data normality. Due to the non-normality of the data, Wilcoxon test was used to compare the differences between the two groups before and after the intervention. Fisher exact test was used to assess whether the intervention and control groups differ in each of the evaluation metrics.

**Fig. 3** The mean of No-show rate in the five intervention group clinics before and after the intervention

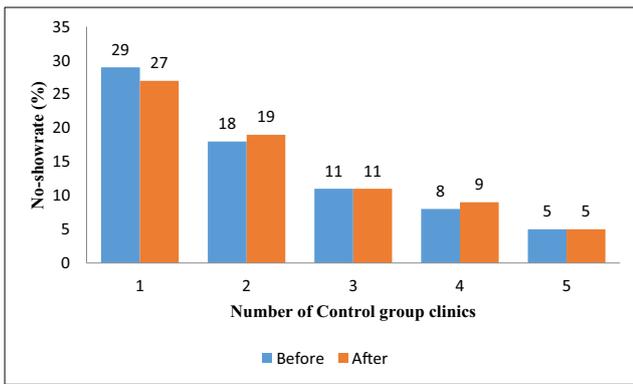


Fig. 4 The mean of No-show rate in the five control group clinics before and after the intervention

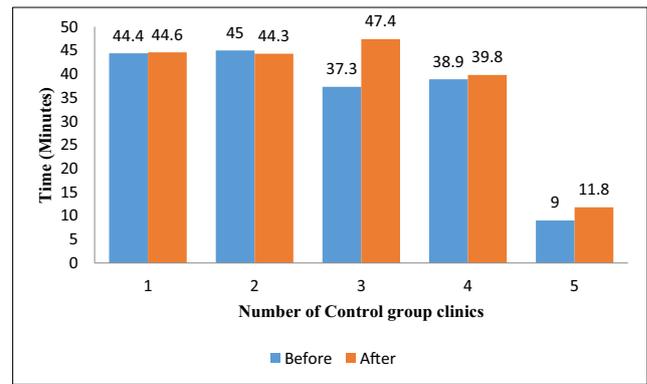


Fig. 6 The mean of Patient waiting time in the five control group clinics before and after the intervention

Results

A total of 470 checklists containing 9034 patients’ information and 460 checklists containing 9130 patients’ information were completed at the pre- and post-implementation phases by clinics secretaries, respectively. The evaluation metrics were compared before and after the implementation of the online appointment scheduling system to evaluate the effectiveness of the system. Table 3 shows the evaluation metrics before and after the intervention in the five intervention group clinics. As shown in Table 3, there were significant differences between the pre- and post-implementation phases regarding Patient waiting time, No-show rate, and Physician punctuality metrics. There was no significant difference regarding the change in other metrics.

Table 4 shows the evaluation metrics before and after the intervention in the five control group clinics. According to the results, there was no significant difference between the evaluation metrics in control group before and after the intervention.

Table 5 shows the mean difference of each metric in the two intervention and control groups before and after the intervention. In other words, this table shows the

intervention effectiveness on each metric in the two intervention and control groups.

Figures 3, 4, and 5 show the variations in the three metrics means, including No-show rate, Patient waiting time, and Physician punctuality before and after the implementation of the online appointment scheduling system in the five intervention group clinics. Also, the variations in these three metrics means before and after the implementation of the online appointment scheduling system in the five control group clinics were shown in Figs. 6, 7, and 8.

Discussion

The results of 930 completed checklists before and after the intervention indicated that the online appointment scheduling system had a significant positive effect on the improvement of the three metrics means, including Patient waiting time (38.2 min before vs. 23.8 min after the intervention), No-show rate (25% before vs. 11% after the intervention), and Physician punctuality (-30 min before vs. -14.2 min after the intervention).

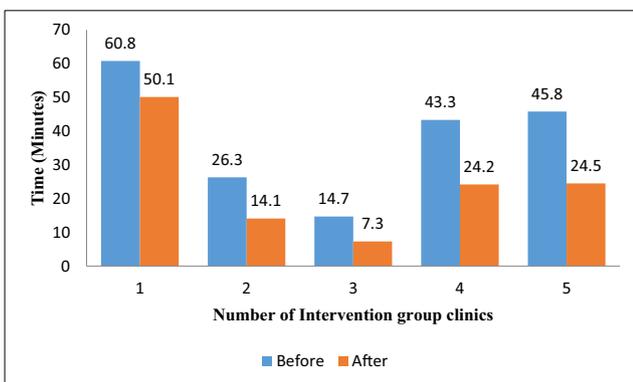


Fig. 5 The mean of Patient waiting time in the five intervention group clinics before and after the intervention

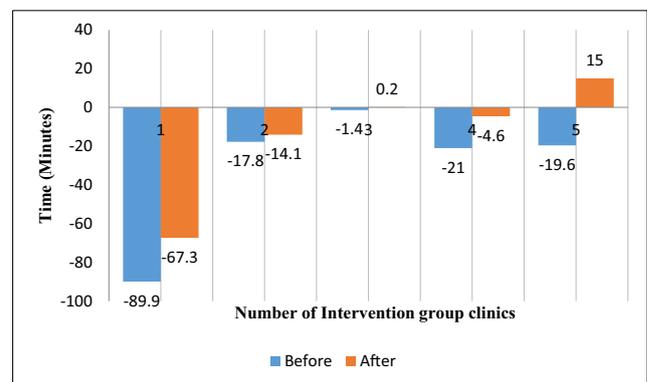


Fig. 7 The mean of Physician punctuality in the five intervention group clinics before and after the intervention

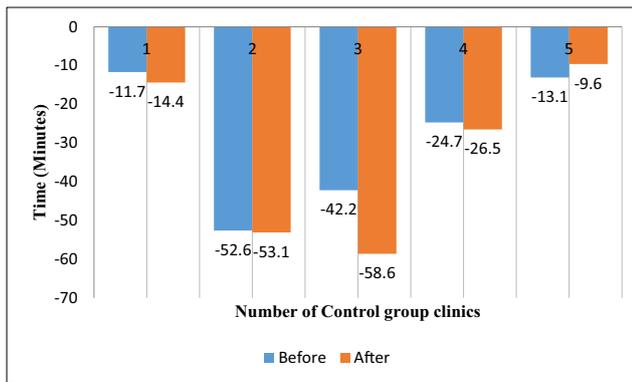


Fig. 8 The mean of Physician punctuality in the five control group clinics before and after the intervention

It also improves other metrics, including Service time (9.6 min before vs. 10.6 min after the intervention), Walk-in rate (20% before vs. 15% after the intervention), and Clinic size (20.8 before vs. 16.6 after the intervention); However, these changes were not significant ($P > .05$).

In our population, the reasons for improving these three metrics can be as follows: The physician's punctuality metric improved for two reasons; firstly, due to sending a reminder text message to physicians in order to remind them the appointment time of their first patient on each working day, and secondly, due to the interest and eagerness of physicians in using the online appointment scheduling system and their greater collaboration in setting up this system. The patient waiting time metric also improved for two reasons; firstly, the service time of each patient was determined based on the previous performance of the physician in the before stage. This means that for all 10 clinics, the average patients' service time during the three months before the implementation of the online appointment scheduling system was calculated. Then with physician's consent, this time was considered and recorded as the patient's service time in the system. This act reduced the fluctuation in the service time of different patients, and consequently, reduced patients' waiting time. Secondly, sending a reminder text message to patients in order to remind them the time and day of their appointment caused a reduction in patient's waiting time and no-show rate.

One of the most important factors in appointment scheduling systems is Patient waiting time, which has been evaluated in many studies [6, 18, 19]. In several studies, the impact of this metric has been investigated on other metrics of appointment scheduling systems such as No-show rate. Studies have shown that increase in the amount of Patient waiting time increases the No-show rate, and there is a close relationship between the two [9, 20–22]. Similar to these results, in the present study, decrease in the amount of Patient waiting time after the intervention caused No-show rate to be reduced. In the present study, there was an improvement in Physician

punctuality metric, which can be due to the use of reminder SMS sent to the physicians to remind them appointment time of their first patient in each working day. This feature was one of the benefits of the designed appointment scheduling system. Studies have shown that when a physician delays in entering the clinic, this lateness leads to the delay in the onset of the first visit, and consequently, the others. This event increases Patient waiting time [23, 24]. Thus, Physician punctuality affects two important metrics of appointment scheduling systems: Patient waiting time and No-show rate [25].

According to Figs. 3, 4, and 5, the highest increase in mean was observed in Physician punctuality (34.6) in clinic no. 5, followed by Patient waiting time (21.3) in the same clinic. Also, the highest decrease in mean was observed in No-show rate in clinics no. 4 and 5 (25 and 24%, respectively). Such a situation was also observed in the control group clinics. Although no change was observed in No-show rate mean in none of the control group clinics before and after the intervention, the highest decrease in Physician punctuality (16.4) and increase in Patient waiting time (10.1) mean was observed in clinic no.3 (Figs. 6, 7, and 8). These results showed a close relationship between these three metrics.

This study had several strength points. Firstly, previous interventional studies with similar aim examined a limited number of evaluation metrics of appointment scheduling systems while in the present study, it was attempted to include as maximum metrics as possible [6, 9, 26]. Secondly, the present study was conducted in several clinics with a large sample size (18,164 patients), and its results can be cited. Finally, a recent study conducted in Iran showed that only 13.03% of Iranian hospitals had an active online appointment scheduling system [27]. There is also no accurate statistics on the proportion of clinics that use actively an online appointment scheduling system. Therefore, the present study results could be effective in encouraging the use of these systems in clinics and health care centers.

Our study limitation was that the assessment was done as a before-after evaluation; however, five clinics were used as control group along with the intervention group clinics in order to minimize the weakness of the study. Therefore, it is suggested that a Cluster RCT (*Randomized Controlled Trial*) be conducted to more accurately assess the impact of an online appointment scheduling system. As the future work, the adoption of this system would be evaluated in target population.

Conclusion

The present study showed that the use of an online appointment scheduling system was successful in improving several evaluation metrics, including Patient waiting time, No-show rate, and Physician punctuality and was able to satisfy all five intervention group clinics, resulted in its continued usage.

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Compliance with ethical standards

Conflict of interest Authors declare that they have no conflict of interest.

Ethical approval This study was approved by Mashhad University of Medical Sciences. The permission was obtained from the Ethics Committee with No. IR.MUMS.fm.REC1395.312. All procedures performed in the study were in accordance with the 1964 Helsinki declaration and its later amendments.

Informed consent All physicians and staff of clinics participated voluntarily and were verbally informed about their privacy.

Appendix 1

Checklist for Evaluating Appointment Scheduling Metrics

Clinic No:

Date:

Secretary:

1- Physician's arrival time:

..... (Hour: Minute)

2- First appointment time was given to the first patient:

..... (Hour: Minute)

3- Number of patients getting appointment today:

.....

4- Number of patients visited by the physician today:

.....

5- Number of patients who walk in without appointments today:

6- Number of patients who missed appointments today:

.....

No	Patient appointment time	Patient arrival time to the clinic	Patient arrival time to Doctor's room	Patient departure time from Doctor's room
1				
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