Original article

Impact of adjustment measures on reducing outpatient waiting time in a community hospital: application of a computer simulation

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Keywords: *waiting time; outpatient; appointment system*

Background As an important determinant of patient satisfaction, waiting time, has gained increasing attention in the field of health care services. The present study aimed to illustrate the distribution characteristics of waiting time in a community hospital and explore the impact of potential measures to reduce outpatient waiting time based on a computer simulation approach.

Methods During a one-month study period in 2006, a cross-sectional study was conducted in a community hospital located in Shanghai, China. Baseline data of outpatient waiting time were calculated according to the records of registration time and payment time. A simulation technique was adopted to investigate the impact of perspective reform methods on reducing waiting time.

Results Data from a total of 10 092 patients and 26 816 medical consultations were collected in the study and 19 947 medical consultations were included. The average of the total visit time for outpatients in this hospital was 43.6 minutes in the morning, 19.1 minutes in the afternoon, and 34.3 minutes for the whole day studied period. The simulation results suggested that waiting time for outpatients could be greatly reduced through the introduction of appointment system and flexible demand-orientated doctor scheduling according to the numbers of patients waiting at different time of the workday.

Conclusion Adoption of an appointment system and flexible management of doctor scheduling may be effective way to achieve decreased waiting time.

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As an important determinant of patient satisfaction, waiting time, has garnered attention in the field of health care services. In mainland of China, there are increasing numbers of visits to community hospitals for medical consultation and help. The increase of visits to community hospitals can be partly explained by lower costs, increasing demands from patients, hospitals' improved service quality and medical insurance policy orientation. Consequently, these community hospitals are facing the challenge of improving service to meet patient demands with limited staff resources. Many patient complaints come from the long waiting time and long waiting times at outpatient clinics has been shown to be the major dissatisfaction with medical care delivery and a barrier to further use of healthcare facilities by affected patients.[1-5]

When considering patient waiting time, there are two separate types for outpatients. One is the interval between the date of the family doctors' referral and the date of the first appointment. Another is the time that elapses between a patient's arrival at the outpatient department and his/her entry into the consulting room.[6] The former was widely studied worldwide, especially in England; partially due to the availability of medical resources and easy access to the Health Care System.[7] The latter for outpatients also attracted much attention,[8] it can be further divided into two subcategories: waiting before consultation and waiting after consultation. The waiting before consultation is generally longer than after consultation and waiting before consultation is prevalent in health care systems where patients are not given time-specific appointments and no appointment system is established. Waiting can be greatly decreased by the introduction of an appointment system. The effectiveness of an appointment system depends on the rate of patients using this system, and higher rate of walk-in patients would limit its effect.[9] However, the waiting time after consultation relies on the collective efforts made by the hospital auxiliary departments.

Only a few attempts have been made to determine the importance of waiting time for clinical treatment and

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hospital admission in mainland of China. With the reforms of the medical insurance system in China, patients have more options to select institutions for their consultation. Most patients want shorter waiting times along with accurate diagnosis and treatment. Many factors appear to contribute to the long waiting time. These factors include, but are not limited to; the health insurance system, the time sense of doctors and patients, patients' behavior while seeking consultation, and insufficient outpatient service power. Increasing resources is the easiest way to solve the long waiting time problem, but resources are limited in mainland of China. It is critical for managers to know how to allocate the limited resources to the right place at the appropriate times. More data are needed for policy-making evaluation before the new plans are implemented, and simulation skill is a suitable decision-making support tool.

The present study aimed to illustrate the distribution characteristics of waiting time in a community hospital located in Shanghai, China and explore the impact of potential measures to reduce outpatient waiting time in the studied hospital based on a computer simulation approach.

METHODS

Study setting

In 2006, from July 1 to July 31, a cross-sectional study was conducted at a 55-bed community hospital in Shanghai, a typical community health center that provides basic health services mainly for nearby communities. As there was no significant difference in the pattern of outpatients' arrival and departure in different months, the month of July was selected at random as the study period. This hospital is one of the earliest hospitals to utilize a system of recording the patient's exact payment time for medical services, which makes it possible to trace the patients' arrival, departure, and various occurrences during clinical consultation. This hospital consists of 85 staff members, including 53 doctors, 22 nurses and 10 technological staff. There are nine major clinical departments and two adjunct departments. The outpatient department of this hospital does not provide emergency services. The operations were performed between 8:00 to 11:30 in the morning, and 13:00 to 16:00 in the afternoon on weekdays and from 8:00 to 11:30 on Saturday.

Data source and inclusion procedure

Data of visits during the above mentioned period were retrieved from the computerized hospital clinical database. The whole process of medical consultation (Figure 1) included different combinations of the following events; triage registration, waiting for consultation, consultation (which included simple physical examinations, such as auscultation or blood pressure measurement), physical examination, laboratory tests, diagnosis, treatment and payment. In some cases, outpatients did not need to register because they were receiving medical services and had registered on the previous day.

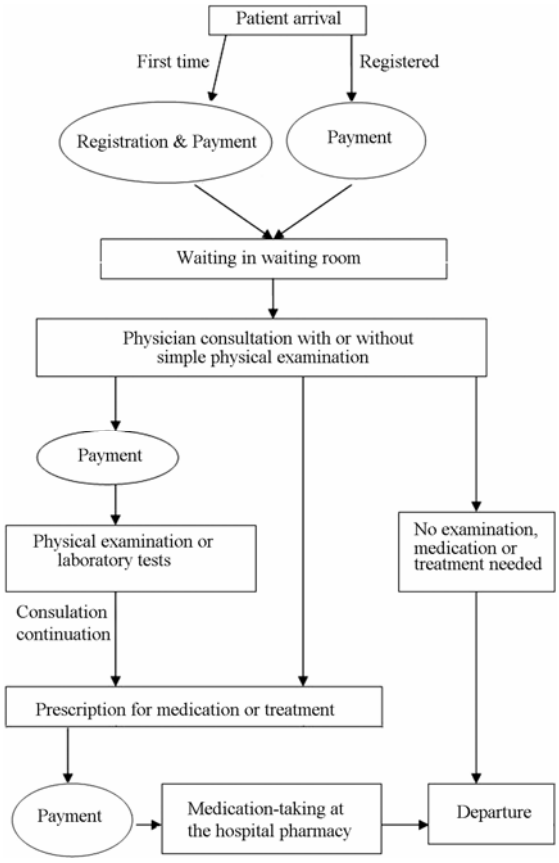

Figure 1. The main process of medical consultation.

Data for each included patient were enrolled from the time of payment for registration until the time of payment for medication. Multiple elements of descriptive data were entered for each patient visit, including name, data of visit, age, sex, final diagnosis, insurance type, time of payment for triage registration, and time of payment for medication. Inclusion criteria were the following: (1) patients received a medical examination and/or laboratory test, but did not receive further medical treatment after consultation, (2) patients' visit ended in payment for medication.

Waiting time definition

Total visit time was defined as the time from the patient arrival until departure. In this study, arrival time was defined as the payment time for registration, and departure time was defined as the time of payment for medication. Two measurements of waiting time were adopted in the present study: physician waiting time (PWT, defined as the time from triage registration until medical consultation) and total waiting time (TWT, defined as the difference between total visit time and the duration of medical service). Patients who only medication-taking waited mainly before the consultation and those who had medical examinations and/or laboratory tests waiting after consultation were a more critical issue.

Simulation approach

A fictitious appointment system was introduced into the study that let all patients arrive and register 10 minutes before his or her consultation. In our database, the exact service time for outpatients was not available and the consultation duration was set as five minutes for all patients. All included visits were divided into 13 groups according to their actual PWT. Saved time was defined as the actual PWT plus consultation period and the above mentioned 15 minutes. The rate and patterns of defaulted appointments were then explored by the data.

Four morning plans were designed on the premise that the same service ability of the outpatient department was maintained. For the first three plans, the adjustment scale was set as 10%, 20% and 30% for the period between 8:00 and 9:00 and the period between 10:00 and 11:00. For the fourth plan, 10% more doctors were arranged between 9:00 to 10:00 and 10% of the doctors were removed from the schedule between 10:00 and 11:00. Saved waiting time and its corresponding average was calculated according to the adjusted doctor schedule and comparisons were made between the effects of these plans.

Statistical analysis

Descriptive statistics revealing the number and the percentage of included visits were tabulated. Analysis of qualitative data was performed using frequency distributions, and a one-sample Kolmogorov-Smirnov test was used to test whether variables were normally distributed. χ^2 test was performed for the comparisons of waiting time:

$$x^2 = \sum \frac{(O-T)^2}{T},$$

where O was the observed value and T was a theoretical value with $df=n-1$, n was the number of observed values. The level of statistical significance was set as 0.05 and P value less than 0.05 was considered statistically significant. The data were managed by Microsoft Excel; the statistical analyses and stimulation were conducted using SPSS 12.0 for windows.

RESULTS

Baseline characteristics

During the study period a total of 10 092 patients and 26 816 medical consultations were collected. About 25.6% of the visits were excluded leaving 19 947 medical consultations included in the present study (Table 1).

Table 1. Description of collected and included visits

Consultation process	Total visits (*n* (%))	Included visits (*n* (%))
Registry-consultation-departure	481 (1.8)	0 (0)
Registry-consultation-pharmacy	21 711 (81.0)	19 164 (71.5)
Registry-consultation-check	568 (2.1)	362 (1.3)
Registry-consultation-laboratory	731 (2.7)	421 (1.6)
Registry-consultation-medical treatment	2543 (9.5)	0 (0)
Registry-consultation-other	4 (0.0)	0 (0)
Registered in previous day	778 (2.9)	0 (0)
Total	26 816 (100)	19 947 (74.4)

Baseline characteristics of the daily average number of patients and total visit time are presented in Table 2. On average, the hospital provided outpatient services for 787.7 patients per day, among which, 457.4 patients (58.1%) came for medical consultations in the morning. Patients older than 50 years old were the majority, composing more than 80% of all the patients. The total visit time followed the normal distribution, so the average was adopted to describe the concentration tendency. The average of total visit time for outpatients in this hospital was 43.6 minutes in the morning, 19.1 minutes in the afternoon and 34.3 minutes for the whole day during the study period. The total visit time for patients arriving in the morning was twice as long as that for patients arriving in the afternoon. No statistically significant differences were found among the waiting time of different age groups, genders and working days; so these categories were not adopted in the following analysis.

Figure 2 shows the arrival and departure characteristics of patients. On average, patient arrival peaked at 7:40 and 7:50 and reached a trough during lunch time. The average number of departure patients was about 19 per 10 minutes for the whole work day. The largest number of patients on the consultation waiting list was 84.8. Figure 1 also shows that there were about 10 patients in the waiting list at noon.

Relationship between arrival time and total visit time

Figure 3 shows the relationship between arrival time and total visit time. Generally, total visit time for patients who arrive in the morning exceeded 30 minutes. Those patients who arrived later than 11:00 spent less time, however they might take risks of not being treated until 13:00. The relationship between arrival time and total visit time was that the earlier one arrived, the longer they typically had to wait.

Relationship between arrival time and total visit time for re-consultation

Whether re-consultations may cost less total visit time was also investigated in the study. Included visits were divided into four parts according to times of visit in the study period and patients who visited five times or more in the month were excluded from this analysis. Table 3 indicates that patients who visited the hospital twice or more usually spend more time for the latter visit than that for the former one. We also found that patients were unaware of the longer waiting time that occurred at the beginning of the day and tended to arrive earlier for the re-consultation.

Adoption of appointment system

The above-mentioned results indicated that the patients' arrival and departure pattern caused longer total visit times. A simulation method was adopted to investigate the impact of perspective reform methods on reducing waiting time. All included visits were divided into 13 groups according to their PWTs. Table 4 shows the PWT

Table 2. Characteristics of daily average number of patients and total visit time

Index	Morning		Afternoon		Whole day	
	Percent (%)	Total visit time (minutes)	Percent (%)	Total visit time (minutes)	Percent (%)	Total visit time (minutes)
Total	100.0	43.6	100.0	19.1	100.0	34.3
Age (years)						
20–29	1.3	45.6	1.3	20.4	1.3	35.9
30–39	3.5	45.9	3.2	18.3	3.3	36.0
40–49	11.5	44.1	12.0	20.3	11.7	34.9
50–59	25.0	42.7	25.3	19.2	25.2	33.7
60–69	27.2	44.1	28.1	18.9	27.6	34.3
70–79	23.7	43.8	22.4	18.6	23.1	34.5
80–89	7.8	41.4	7.7	17.9	7.8	32.5
χ^2 values		0.3336		0.2886		0.2616
P values		0.9993		0.9996		0.9997
Sex						
Male	43.7	44.1	43.9	19.3	43.8	34.7
Female	56.3	43.1	56.1	18.8	56.2	33.9
χ^2 values		0.0115		0.0066		0.0093
P values		0.9147		0.9354		0.9231
Working day						
Monday	17.6	46.3	25.3	23.6	20.8	35.6
Tuesday	19.0	46.1	21.4	18.3	20.0	34.7
Wednesday	17.7	41.2	19.3	14.9	18.4	30.6
Thursday	13.9	39.3	17.4	18.5	15.4	30.3
Friday	16.2	39.1	16.6	18.9	16.3	31.3
Saturday	15.7	48.9	–	–	9.1	48.9
χ^2 values		1.9789		2.0484		7.0522
P values		0.8521		0.7269		0.2168

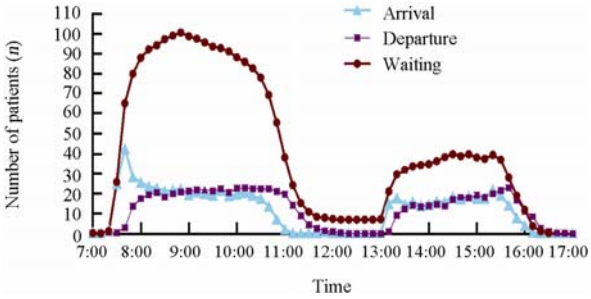

Figure 2. Average arrival, departure, and waiting patient at different time of a day.

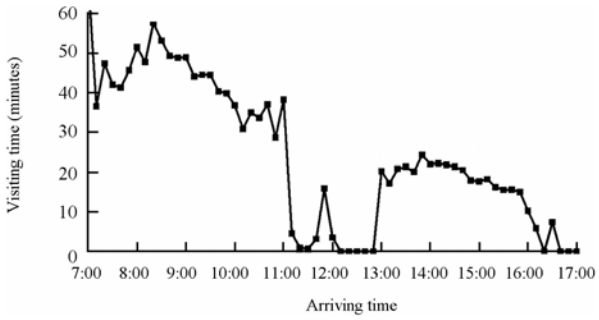

Figure 3. Average of total visit time of the patients that arrived at different moment.

that might be saved if the appointment was strictly executed according to these assumptions. The reduced waiting time under circumstances with different utilization rates was also explored. If 100% of patients were covered by the appointment system and arrived punctually, the PWT could be reduced by 16.6 minutes and the fractional time saving would be 52.5% (16.6/31.6×100%). If 60% of patients were covered, the fractional time saving would be 31.5% (52.5%×60%), and if 30% of patients were covered, the saved time would be 15.8% (52.5%×30%).

Flexible management of doctor scheduling

The strategy to cope with waiting time was set as flexible management of doctor scheduling. Whether flexible doctor scheduling can work was explored in the study. Four morning plans were designed to arrange more doctors between 8:00 and 9:00 or from 9:00 to 10:00, and reduce the number of doctors between 10:00 and 11:00. These plans maintained the same level of service. From Table 5 and Figure 4, it can be seen that if more doctors worked in the out-patient department between 8:00 and 9:00, waiting time would be reduced and the waiting list would be shortened. For plan A, a coefficient of 1.3 or 0.7 was given to the total visit time and the number of departure patients in the studied period, and the average saved time could be calculated. Similar calculations were made for the other three plans with different coefficients. The effect of flexible doctor scheduling in the afternoon was less significant than it was in the morning because of fewer waiting patients (data not shown).

DISCUSSION

Patient satisfaction is a worthwhile goal of health care service,[10-13] and there are a lot of reasons for implementing plans to achieve it. It has been suggested that waiting time is the most important determinant of patient satisfaction. And waiting time statistics have become an important standard by which health care is measured.[14-16] Waiting time statistics also hold great promise to facilitatethe evaluation of performance of health care institutions.[17-21] Long waiting times induce negative effects on the quality of the hospital before finally

Table 3. Visit times and total visit time

Visit times	Time segments	Total visit time (minutes (patients proportion of the whole day, %))			
		1st visit	2nd visit	3rd visit	4th visit
1 (*n*=5377)	Morning	40.9 (60.9)			
	Afternoon	18.2 (39.1)			
	Whole day	32.0 (100)			
2 (*n*=2201)	Morning	37.9 (60.0)	48.0 (65.3)		
	Afternoon	18.8 (40.0)	20.3 (34.7)		
	Whole day	30.3 (100)	38.4 (100)		
3 (*n*=1183)	Morning	39.5 (65.2)	41.3 (64.7)	51.4 (65.2)	
	Afternoon	18.5 (34.8)	19.5 (35.3)	18.9 (34.8)	
	Whole day	31.1(100)	33.6 (100)	40.1(100)	
4 (*n*=637)	Morning	40.2 (58.9)	41.3 (65.1)	48.7 (62.2)	53.9 (62.2)
	Afternoon	18.6 (41.1)	19.0 (34.9)	21.9 (37.8)	19.2 (37.8)
	Whole day	31.3 (100)	33.5 (100)	38.6 (100)	40.8 (100)

Table 4. Saved waiting time after the introduction of an appointment system

Groups	Physician waiting time before consultation (minutes) (1)	Number of visits (*n*) (2)	Average physician waiting time plus consultation (minutes) (3)	Average total visit time after consultation (minutes) (4)	Total visit time (minutes) (5)=(3)+(4)	Saved time (minutes) (6)=((3)–15)×(2)
1	1–4	1063	2.7	6.1	8.8	–13 033.8
2	5–9	2872	7.5	3.6	11.2	–21 405.7
3	10–14	2625	12.5	2.4	14.9	–6 563.9
4	15–19	2261	17.4	2.6	20.1	5 505.9
5	20–24	1912	22.4	1.8	24.2	14 121.3
6	25–29	1632	27.4	2.6	29.9	20 210.3
7	30–59	5261	42.3	2.5	44.8	143 793.1
8	60–89	1630	71.6	1.5	73.1	92 222.1
9	90–119	395	101.5	2.5	104.0	34 158.8
10	120–179	155	141.0	2.6	143.6	19 532.6
11	180–239	34	206.6	1.4	208.0	6 512.9
12	240–299	36	271.4	3.2	274.6	9 231.8
13	300–360	71	380.1	5.1	385.2	25 921.9
Total		19947				330 207.3
Average			31.6	2.7	34.3	16.6

Table 5. Saved waiting time for four plans

Plans	Adjustment to the number of doctors (%)			Saved waiting time (minutes)	Average of saved waiting time (minutes)
	8:00–9:00	9:00–10:00	10:00–11:00		
A	+30	0	–30	4036	9.0
B	+20	0	–20	2691	6.0
C	+10	0	–10	1346	3.0
D	0	+10	–10	760	1.7

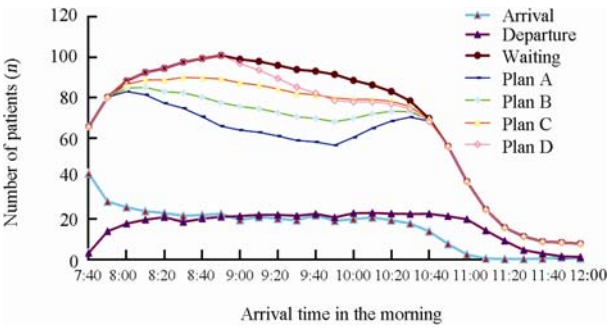

Figure 4. Comparisons of actual and modeled patient distributions.

crippling the competitive advantages of the hospital. Understanding the current situation of waiting time and exploration of possible strategies to reduce waiting time are the objectives of the present study. Long waiting time in an outpatient setting is very common in hospitals in either Shanghai or other cities of China. Waiting times varies among different scales of hospitals. According to the Japan Ministry of Health, Labor, and Welfare, the percent of the outpatients whose waiting time before consultation was less than 30 minutes was 56.1%, 43.0%, and 37.3% for small, middle, and large scale hospitals, respectively. As it is difficult to know the waiting time distribution of different levels of hospitals, we just limited our focus to the community hospital. Community hospitals play an important role in the primary health care system, and there are increasing visits to community hospitals due to lower costs, medical insurance policies, and other reasons.

This study found that patient arrivals tended to be concentrated in early morning, and the departures occurred at a relatively stable rate. The relationship between arrival time and waiting time was that the earlier one arrived, the longer they typically waited. We assumed that the average service time was the same for every patient, and that gave us with two basic methods to reduce total visit time and waiting time for outpatients.

One is to adjust the patients' arrival, and the other is to adjust medical service provision. Comprehensive understanding of the waiting time distribution and measures to reduce the number of patients arriving late for appointments are vital to improving the clinic efficiency.[22]

Implementing a new plan is costly and often requires additional changes in the current working process. The alternative is to use computer simulations to predict the impact of changes on outcomes. Computer simulation is a powerful tool that can support evidence-based health care policies and management in a risk-free environment. The use of a simulation to test alternative plans can improve efficiency at a minimal cost. The results of this case study in a community hospital indicated the usefulness of a simulation in decision-making under uncertain conditions. The hospital management has entered into the era of informatics, patient-related data and information are easily collected and analyzed. Simulation techniques based on real data may facilitate managers' understanding of the current situation regarding waiting time and potential measures while avoiding the risks of making insufficiently informed decisions. This study indicated that patients who visited the hospital two or more times usually spend more waiting time for the latter visit than the former one. More dissemination about waiting time and other actions are needed to solve this problem.

Reducing outpatients' waiting time is not only valuable for the patients but also is helpful to decrease the hospital workload. Appointment systems are widely used as a good way to control rate of patients' arriving for consultations. It has been widely used in western countries,[23,24] but not is prevalent in China. Appointments could be patient demand-orientated and doctor-orientated. Hospitals should not expect 100 % of outpatients to use the appointment system, or expect 100% of appointed patients to honor their appointment time.[25] However, with time, walk-in patients would be inclined to use the system when they were made aware of the fact that appointment patients spend less time waiting. Non-attendance is not a big problem, for walk-in patients tend to come earlier. Information on walk-in patients and non-attendance may be useful to improve the appointment system.

The simulation results indicate that demand-oriented doctor scheduling, according to the various number of waiting patients throughout the day, could contribute to reducing waiting time. The other solution to reduce waiting time lies in the idea of flexible scheduling of doctors' clinic time. Some hospitals have been scheduling different numbers of doctors on different weekdays according to the expected number of patients. This idea can also be applied to different working days. These two adjustment measures have different advantages and limitations. For the introduction of appointment system, the efficiency improvement is very significant if all the patients keep their appointment, but it relies on the proportion of patients that keep their appointment. The adoption of an appointment system is costly and the efficiency of this kind of adjustment is very sensitive to the proportion of walk-in patients and the proportion of patients covered by the system. For the flexible doctor scheduling, no additional resources are needed and certain improvement can be obtained. On the premise that time distribution of patient visits is available, the appropriate schedule adjustments at different times are critical to success. Routine surveillance and analyses of the patient visit data and tendencies may contribute to the design of an adjustable schedule. The doctor resources and compliance of the doctors may also affect the feasibility of this kind of adjustment measure.

This study should be viewed in the context of our study's limitations. One of the limitations is the bias associated with survey research in general; the findings might not be able to be generalized to community hospitals with different demographic characteristics, staff and resources. The analysis could be limited by the sample size and by only being conducted in the summer and the lack of statistical power. Additional attention should be paid to differences with other studies that used different inclusion criteria. In future analyses we will consider patients' age distribution, medical visit pattern and clinical needs in different levels of hospitals, and try to incorporate the information into our study of waiting time and patient satisfaction.

In summary, our results provide some insights into the waiting time, which is a barrier to healthcare delivery in community hospitals in the mainland of China. Adoption of an appointment system and flexible management of doctor scheduling may be effective ways to cope with waiting time.

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