J Chin Med Assoc

ORIGINAL ARTICLE

Factors of missed appointments at an academic medical center in Taiwan

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Abstract

Background: Missed appointments mean appointments neither attended nor canceled by patients. Missed appointments belong to one of the important subjects of hospital management because they would incur the inactivity of medical professionals and devices, occupy the health resources for other patients, and thus impair the quality of healthcare services. The aim of this study was to explore the factors of missed appointments at the outpatient department of an academic medical center in Taiwan.

Methods: This was a cross-sectional study based on registration records of an academic medical center in Northern Taiwan in 2015. Fifteen variables of patients, appointments, and weathers were taken into analysis. Logistic regression was used to calculate the adjusted odds ratio of each variable. For nonfirst visits, we further built a logistic regression model with the five most influential variables and the personal attendance pattern of the previous three appointments.

Results: Of 2 132 577 eligible appointments in 2015, the overall no-show rate was 16.9%. The influential factors included the following: (1) patient characteristics: younger than 40 years, ≤6 visits, and a no-show rate between 50% and 75% in the previous year; (2) appointment characteristics: Saturdays, evenings, on the last third of the waiting list, only one appointment on the same day, online appointments, appointment-to-visit intervals (wait time) in 7 to 14 days, appointments to obstetrics/gynecology or pediatrics, first-time appointments, and the interval between the appointed visit and the previous visit in <7 days; and (3) weather characteristics: warm weathers and heavy rains. For nonfirst appointments, the influences in decreasing order were heavy rain, shorter interval between the appointed visit and the previous visit to the same department, higher no-show rate in the previous year, total absence in the personal attendance pattern of the previous three appointments, longer wait time, and children.

Conclusion: The factors of missed appointments were multifaceted. Further measures could be undertaken accordingly to enhance healthcare efficiency.

Keywords: Appointments and schedules; Hospital; No-show patients; Outpatient clinics; Taiwan

1. INTRODUCTION

In the rapidly changing medical environment, healthcare efficiency and patient's satisfaction are usually regarded as important indicators of quality of healthcare services.[1] In the ambulatory sector, a well-operated appointment system could save patients' wait time, enable healthcare providers to allocate resources according to the number of patients, and thus enhance healthcare quality.[2] On the contrary, missed appointments, ie, appointments neither attended nor canceled by patients, have a great impact on healthcare efficiency by incurring the inactivity of professionals and equipment and decreasing the availability of resources to other patients.[1,3–7] A study in the USA revealed that missed appointments could cause 16% to 54% operating loss for medical insurance.[8] Because of different insurance systems and clinic features, the rates of missed appointments ("no-show rates") varied between 15% and 30%.[7,9,10] A 50% no-show rate had even been reported in primary care clinics and 60% in psychiatric clinics.[3,4,6,7,10–14]

The National Health Insurance (NHI) in Taiwan has been implemented since 1995, with 20 759 contracted healthcare facilities and a 99.6% coverage of the population in 2016. An NHI beneficiary pays an average of 15 ambulatory visits annually, far above the average of 6.9 visits in OECD (Organization for Economic Cooperation and Development) countries.[15,16] The high utilization of healthcare services in Taiwan makes a well-operated appointment system indispensable.

To overcome the problem of missed appointments, hospitals in Taiwan often restrict the appointments by patients who have frequently missed appointments but this measure would lead to patients' dissatisfaction and more work for on-site registrations. The literature indicated that the appointment system should consider the local medical environment and population structure that might affect the efficacy of interventions.[11] Although most studies of missed appointments focused on a single specialty with fewer data and shorter periods of observation, no large-scale empirical analysis of the situation in Taiwan was available. The aim of this study was to identify the factors of missed appointments with a large dataset involving multiple specialties of an academic medical center. Our results might serve as the

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Conflicts of interest: The authors declare that they have no conflicts of interest related to the subject matter or materials discussed in this article.

Journal of Chinese Medical Association. (2019) 82: 436-442.

Received October 18, 2018; accepted December 23, 2018.

doi: 10.1097/JCMA.0000000000000068.

basis for designing a suitable appointment system and facilitate the efficiency of healthcare utilization and the equity of resource allocation.

2. METHODS

2.1. Data sources

The data were the registration records of the outpatient department of an academic medical center in Taipei City, Taiwan, from 2014 to 2015. The patients were de-identified for further analysis. Besides regular details, a registration record also contained additional information about the consequences: cancellation or completed attendance. This study has been approved by the Institutional Review Board of Taipei Veterans General Hospital (IRB number: 2017-07-008-AE).

2.2. Study design

This was a cross-sectional study of registrations in 2015. Eligible records did not include the canceled appointments, invalid registrations, and administrative anomalies. The records were categorized into two groups: (1) appointments with completed attendances; and (2) missed appointments. To capture the influential factors on each visit, the patients were assumed to make their decision on attendance to each appointment independently, and all appointments were analyzed at the record level using a logistic regression model. That is, we assumed a single patient makes different decision on each of his appointment with 15 influential variables including patient characteristics, appointment characteristics, and weathers characteristics taken into analysis. Logistic regression was used to calculate the adjusted odds ratio (AOR) of each variable. For nonfirst visits, we further built a logistic regression model with the most influential variables and the additional personal attendance pattern of the previous three appointments.

2.2.1. Patient characteristics

The variables included the patient's gender and age. The patients' age were calculated based on the beginning of 2015 (January 1, 2015) and categorized into decades. As birthday is required to make appointments, there are no missing values on age.

2.2.2. Appointment characteristics

The variables included the patients' past visit history (visits made in 365 days before the current appointment), days of the week, the session of day, the rank on the waiting list and the number of appointments on the same day of the appointed visit, the method of appointment, the interval between dates of appointment making and appointed visit (appointment-to-visit interval, wait time), the department to attend, the first visit or not, and the interval between dates of the appointed visit, and the previous visit to the same department.

According to the list of options on the appointment system, the clinical departments were categorized into medicine, surgery, obstetrics/gynecology/pediatrics, ophthalmology/otorhinolaryngology, affiliated clinics, and others (Supplementary Table 1). The appointments could be made by physicians, on discharge from ward, on the registration counter, on-line and via telephone (voice-guided or with aids of the staff). The first visits in the current study were operationally defined as those without preceding appointment or attendance in the past 365 days.

2.2.3. Weather characteristics

The weather was at first divided into cold (10°C-15°C), cool (16°C-19°C), comfortable (20°C-26°C), warm (27°C-30°C), and hot (above 30°C) according to the 2015 average daily temperatures of Shipai Area in Northern Taiwan that were published by Taiwan Central Weather Bureau. On the basis of the daily precipitation, the weather was additionally divided into no rain (0 mm), rain (0-80 mm), and heavy rain (>80 mm).

2.2.4. Personal appointment patterns for nonfirst visits

For each appointment, the personal appointment pattern was operationally defined as the status of the previous three appointments by the patient. The pattern was displayed with three binary digits where the first digit represented the status of the earliest appointment of the previous three appointments and the third digit represented that of the last appointment. As the notation, 0 represented a missed appointment, 1 represented completed attendance(s), and the underscore '_' represented not available.

2.3. Data processing and statistical analysis

We used Microsoft SQL Server 2016 for data linkage and extraction, Stata release 15 for statistical analysis, and Microsoft Excel 2016 for producing tables and figures. At first, we performed the univariate analysis and calculated no-show rates in each variable. Then, we used the multivariate logistic regression to calculate the AORs of missed appointments in each variable. Within each variable, the item with the minimal value served as the reference. For nonfirst appointments, we further built a logistic regression model with the personal attendance pattern of the previous three appointments and those variables having item(s) with an AOR > 1.5 in the previous regression model. In the current study, we set the heuristic threshold of effect size of AOR at 1.5 to select both statistical significance and clinical meaningful predictors in our model. The 95% CIs were calculated based on normal approximation to represent statistical significances. The adjusted no-show rates were calculated for appointments of each characteristic as they were average on all other characteristics. Those rates were interpreted as the predicted probabilities of missed appointments if they were average in all other respects. A two-tailed level of 0.05 was considered statistically significant.

3. RESULTS

In 2015, a total of 2 132 577 appointments with 1 771 416 completed attendances were included for analysis. The overall no-show rate was 16.9% (n = 361 161). Among four-patient variables, higher no-show rates were observed in female (17.6%), younger than 40 years (22.0%-29.2%), ≤ 6 visits (19.5%) and a no-show rate higher than 50% in the previous year (39.0%-41.0%). Among nine-appointment variables, higher no-show rates were observed in appointed visits on Fridays and Saturdays (18.4%-19.1%), in the evenings (23.7%), on the last third of the waiting list (17.9%), only one appointment on the same day (17.7%), on-line appointments (20.1%), appointment-to-visit intervals in 7 to 14 days (19.7%), appointments to obstetrics/gynecology or pediatrics (26.2%), first visits (19.0%), and the interval between the appointed visit and the previous visit to the same department ≤7 days (22.0%). Of two weather variables, warm weather (17.9%) and heavy rain (51.4%) had higher no-show rates (Table 1).

Furthermore, we used the multivariate logistic regression model to identify the independent predictors of missed appointments. Of 15 variables of patients, appointments and weathers, only gender had no significant effect on no-show rates (p = 0.877) (Table 2). Five variables had an item with an AOR > 1.5: age, no-show rate in the previous year, appointment-to-visit interval, the interval between the appointed visit and the previous visit to the same department, and rain.

Of all appointments in 2015, nonfirst appointments accounted for 82.9% (n = 1 767 122). For them, we performed the multivariate logistic regression model again by involving the above-mentioned five variables plus the personal appointment pattern. All six variables remained statistically significant after adjustment. The influences in decreasing order on the basis of AOR were heavy rain (AOR: 6.223, adjusted no-show rate: 51.1%), shorter interval (<7 days) between the appointed visit and the previous visit to the same department (AOR: 3.906, adjusted no-show rate: 34.6%), higher no-show rate (75%-100%) in the previous year (AOR: 3.274, adjusted no-show rate: 34.3%),

Table 1

Characteristics of appointments and no-show rates in the outpatient department of an academic medical center in Taiwan, 2015 (n = 2 132 577)

Factors	% of appointments %[a]	No-show rate %	95% CI
Total appointments	100.0	16.9	16.9-17.0
Patients' characteristics			
Gender			
Male	50.5	16.3	16.2-16.4
Female	49.5	17.6	17.5-17.6
Age, y			
0-9	2.7	29.2	28.8-29.5
10-19	2.3	22.0	21.7-22.4
20-29	4.5	25.8	25.6-26.1
30-39	7.4	25.2	24.9-25.4
40-49	9.9	19.4	19.2-19.6
50-59	16.3	16.1	16.0-16.2
60-69	20.1	14.2	14.1-14.3
70-79	15.4	13.8	13.7-13.9
80-89	17.2	14.1	14.0-14.2
≥90	4.0	16.1	15.8-16.3
Appointment characteristics			
Past visit history			
Total visits in the past 365 days			
≤6	51.8	19.5	19.5-19.6
7-12	19.3	14.6	14.5-14.8
13-24	17.9	13.6	13.5-13.7
25+	11.1	14.2	14.1-14.3
No-show rate of the past 365 days			
0%-25%	82.7	14.2	14.2-14.3
25%-50%	14.1	27.7	27.5-27.8
50%-75%	1.8	41.0	40.5-41.5
75%-100%	1.3	39.0	38.5-39.6
First visit			
Yes	17.1	19.0	18.8-19.1
No	82.9	16.5	16.5-16.6
Interval between the appointed visit and the previous visit, d			
<7	27.8	22.0	21.9-22.1
7-14	20.0	19.1	18.9-19.3
15-28	16.9	15.8	15.7-15.9
29-56	11.4	14.9	14.7-15.0
57+	23.8	13.1	13.0-13.3
Day of the week			
Monday	19.6	16.6	16.5-16.7
Tuesday	19.3	17.2	17.1-17.3
Wednesday	20.7	15.7	15.6-15.8
Thursday	18.4	16.4	16.3-16.5
Friday	15.2	18.4	18.3-18.6
Saturday	6.9	19.1	18.9-19.3
Attendance daytime			
Morning	68.0	16.2	16.2-16.3
Afternoon	31.1	18.7	18.6-18.8
Evening	1.1	23.7	23.2-24.2
Rank on the waiting list			
First third	32.4	15.9	15.8-15.9
Middle third	32.7	16.9	16.8-17.0
Last third	35.0	17.9	17.9-18.0
Number of appointed visits on the same day			
1	82.5	17.7	17.7-17.8
2	14.0	13.0	12.8-13.1
≥3	3.4	14.6	14.4-14.9
Appointment method			
Physician	52.9	17.5	17.4-17.5
Postdischarge	3.1	16.5	16.2-16.8
Registration counter	19.5	12.2	12.1-12.3
On-line	22.7	20.1	20.0-20.3
Telephone	1.8	12.8	12.5-13.1
Appointment-to-visit interval, d			
<7	27.9	15.7	15.0-15.2
7-14	22.5	19.7	19.5-19.8
15-28	25.7	18.1	18.0-18.3
29-56	9.3	16.5	16.3-16.6
57+	14.6	15.7	15.6-15.8
Department to attend			
Medicine	46.6	15.8	15.7-15.9
Surgery	20.2	16.7	16.6-16.8
Obstetrics, gynaecology, pediatrics	7.2	26.2	26.0-26.4
Ophthalmology and ENT	12.1	16.3	16.2-16.5
Affiliated clinic	0.9	10.9	10.4-11.3
Other	13.1	17.3	17.1-17.4
Weather characteristics			
Temperature, ºC			
Cold (10-15)	12.4	15.9	15.8-16.1
Cool (16-19)	20.0	16.7	16.6-16.8
Comfortable (20-26)	40.1	16.8	16.7-16.8
Warm (27-30)	25.4	17.9	17.8-18.0
Hot (31+)	2.0	16.6	16.2-16.9
Rain			
No (0 mm)	58.1	16.5	16.4-16.5
Small (0-80 mm)	41.1	17.0	16.9-17.0
Heavy (>80 mm)	0.8	51.4	50.7-52.2

[a]The total percentages within a specific factor might exceed 100% because of rounding.

total absence in the personal attendance pattern of the previous three appointments (AOR: 3.051, adjusted no-show rate: 31.9%), longer appointment-to-visit intervals (≥ 57 days) (AOR: 2.537, adjusted no-show rate: 22.1%), and children under 10 years (AOR: 2.005, adjusted no-show rate: 25.0%) (Table 3). The differences of items in each of the six variables were displayed in the Fig. 1.

4. DISCUSSION

This study demonstrated that with the exception of patients' gender all of the other characteristics of patients, appointments, and weathers played roles in no-show rates. We believed that our findings could apply to other academic medical centers in Taiwan and the identified factors could be targeted for interventional measures to improve the appointment system and thus decrease the no-show rates.

The overall no-show rate in our study was 16.9%, comparable with 14% to 20% reported in other academic medical centers in Taiwan.[14,17,18] Among the methods of appointments in our study, more than half of appointments were made by physicians, but on-line appointments had the highest no-show rate. This finding was consistent with that reported by Wang et al.[17] It was possible that physicians usually judged the patient's condition and then made appointments for follow-ups. On the contrary, the patients might not have professional recommendations before making on-line appointments. Although medical departments accounted for the majority of appointments in our study, obstetrics/gynecology and pediatrics had the highest no-show rate. One of the reasons might be that medical departments had a larger part of patients with chronic diseases who had frequent visits for refills and thus higher compliance rates.[19] In our study, appointments for first visits had a higher no-show rate than those for nonfirst visits. Some studies pointed out that new patients had a longer wait time that lead to a higher no-show rate.[3,7] Although most healthcare facilities offered special reservations for new patients,

Table 2

AOR for missed appointments, 2015 (n = 2 132 577)

	AOR for missed appointments		
	Odds ratio	95% CI	*p*
Patients' characteristics			
Gender			
Male	(ref)		
Female	1.001	0.993-1.008	0.877
Age, y			
0-9	1.677	1.637-1.718	<0.001
10-19	1.331	1.299-1.365	<0.001
20-29	1.665	1.636-1.695	<0.001
30-39	1.543	1.520-1.567	<0.001
40-49	1.238	1.221-1.256	<0.001
50-59	1.078	1.065-1.092	<0.001
60-69	(ref)		
70-79	1.013	0.999-1.026	0.062
80-89	1.30	1.115-1.146	<0.001
≥90	1.313	1.286-1.341	<0.001
Appointment characteristics			
Past visit history			
Total visits in the last 365 days			
≤6	1.185	1.172-1.199	<0.001
7-12	1.009	0.996-1.023	0.206
13-24	(ref)		
25+	1.103	1.086-1.120	<0.001
No-show rate of the last 365 days			<0.001
0%-25%	(ref)		
25%-50%	2.220	2.199-2.241	<0.001
50%-75%	3.566	3.490-3.645	<0.001
75%-100%	2.950	2.875-3.027	<0.001
First visit			
Yes	1.822	1.790-1.853	<0.001
No	(ref)		
Interval between the appointed visit and the previous visit, d			
<7	3.940	3.869-4.013	<0.001
7-14	1.953	1.924-1.983	<0.001
15-28	1.331	1.312-1.351	<0.001
29-56	1.199	1.180-1.219	<0.001
57+	(ref)		
Days of the week			
Monday	1.089	1.076-1.102	<0.001
Tuesday	1.100	1.086-1.113	<0.001
Wednesday	(ref)		
Thursday	1.065	1.052-1.078	<0.001
Friday	1.165	1.150-1.180	<0.001
Saturday	1.125	1.106-1.144	<0.001
Attendance daytime			
Morning	(ref)		
Afternoon	1.111	1.102-1.121	<0.001
Evening	1.011	0.978-1.044	0.635
Rank on the waiting list			
First third	(ref)		
Middle third	1.052	1.042-1.062	<0.001
Last third	1.175	1.163-1.188	<0.001
Number of appointed visits on the same day			
1	1.243	1.228-1.258	<0.001
2	(ref)		
≥3	1.215	1.186-1.244	<0.001
Appointment method			
Physician	1.198	1.181-1.215	<0.001
Postdischarge	1.073	1.048-1.100	<0.001
Registration counter	(ref)		
On-line	1.365	1.347-1.382	<0.001
Telephone	1.074	1.039-1.110	<0.001
Appointment-to-visit interval, d			
<7	(ref)		
7-14	1.454	1.435-1.473	0.015
15-28	1.887	1.861-1.913	<0.001
29-56	2.124	2.082-2.167	<0.001
57+	2.435	2.388-2.484	0.007
Department to attend			
Medicine	1.073	1.022-1.126	<0.001
Surgery	1.084	1.033-1.138	<0.001
Obstetrics, gynecology, pediatrics	1.361	1.294-1.432	<0.001
Ophthalmology and ENT	1.126	1.072-1.183	<0.001
Affiliated clinic	(ref)		
Other	1.152	1.097-1.210	<0.001
Weather characteristics			
Temperature, ºC			
Cold (10-15)	(ref)		
Cool (16-19)	1.032	1.018-1.047	<0.001
Comfortable (20-26)	1.028	1.015-1.040	<0.001
Warm (27-30)	1.064	1.051-1.078	<0.001
Hot (31+)	1.185	1.152-1.220	<0.001
Rain			
No (0 mm)	(ref)		
Small (0-80 mm)	1.048	1.040-1.056	<0.001
Heavy (>80 mm)	5.837	5.650-6.031	<0.001

AOR = adjusted odds ratio.

it seemed that such measures did not meet the patient's needs enough.

In our study, nonfirst appointments accounted for 82.9% of the total appointments and were independently analyzed with the five most influential variables plus the personal appointment pattern of the previous three appointments. We found that younger patients had a higher no-show rate, a finding similar to those in other studies.[2,3,13,14] In general, young patients had relatively better health conditions and fewer chronic diseases but less time for attendances because of school, job, and family responsibility.[10,13,14,20] Furthermore, missed appointments might become habitual. Some studies revealed that patients with a history of missed appointments were more likely to miss again.[17,21] Our study shared similar findings: no-show rate in the previous year had a great influence on the current no-show probability. We also found the personal attendance pattern of the previous three appointments could be another good parameter for identifying habitual no-show patients. The more missed appointments in the previous three appointments, the higher no-show rate in the current appointment. Rachel et al. had also set up a prediction model and found that patients missing three consecutive appointments in 10 appointments had higher no-show rates than those missing three inconsecutive appointments in 10 appointments.[5]

Among appointment characteristics in our study, a longer wait time for appointments was associated with a higher no-show rate. In a study of referrals to a psychiatric clinic, it was demonstrated that one additional week of wait time for appointments would increase 7% of no-show rate.[22] Another study also showed that the no-show rate for appointments with a wait time of more than 2 months could reach 32%.[9] Facing a longer wait time, patients might become anxious and turn to other physicians who could offer an earlier appointment,[1,3,5,7,13,23] what was also a common phenomenon under Taiwan's NHI system without strict regulations of referrals. In addition, because the NHI allowed patients with chronic diseases to have refill prescriptions for 3 months, physicians might accordingly make appointments for 3 months later that could be hardly kept by patients. In our study, the shorter interval (<7 days) between the appointed visit

Table 3

AOR for missed appointments and adjusted no-show rates by patients' appointment and weather characteristics, 2015 (n = 1 767 122)

	AOR for missed appointments		Adjusted no-show rates		
	AOR	95% CI	*p*	%[a]	95% CI
Personal appointment pattern[b]					
000	3.051	2.941-3.164	<0.001	31.9	31.2-32.6
001	1.693	1.643-1.744	<0.001	21.3	20.8-21.7
010	1.597	1.551-1.645	<0.001	20.4	19.9-20.8
011	1.547	1.520-1.575	<0.001	19.9	19.7-20.1
100	1.903	1.851-1.958	<0.001	23.2	22.7-23.6
101	1.537	1.511-1.564	<0.001	19.8	19.6-20.0
110	1.518	1.493-1.544	<0.001	19.6	19.4-19.8
111	(ref)			14.1	14.0-14.2
__0	1.154	1.114-1.195	<0.001	15.8	15.4-16.3
__1	1.239	1.222-1.257	<0.001	16.8	16.6-16.9
_00	1.547	1.450-1.650	<0.001	19.9	18.9-20.8
_01	1.433	1.382-1.486	<0.001	18.8	18.3-19.3
_10	1.120	1.082-1.159	<0.001	15.5	15.1-15.9
_11	1.251	1.231-1.271	<0.001	16.9	16.7-17.1
Patients' characteristics					
Age, y					
0-9	2.005	1.953-2.059	<0.001	25.0	24.6-25.4
10-19	1.544	1.499-1.590	<0.001	20.7	20.3-21.2
20-29	1.739	1.702-1.778	<0.001	22.6	22.3-22.9
30-39	1.631	1.602-1.660	<0.001	21.4	21.4-21.8
40-49	1.287	1.266-1.309)	<0.001	18.1	17.9-18.3
50-59	1.115	1.099-1.132)	<0.001	16.2	16.1-16.3
60-69	(ref)			14.9	14.7-15.0
70-79	0.991	0.975-1.006	0.224	14.7	14.6-14.9
80-89	1.055	1.040-1.071	<0.001	15.5	15.4-15.6
≥90	1.193	1.165-1.221	<0.001	17.1	16.8-17.3
Appointment characteristics					
No-show rate of the last 365 days					
0%-25%	(ref)			14.5	14.4-14.5
25%-50%	2.018	1.992-2.043	<0.001	24.8	24.6-25.0
50%-75%	2.903	2.824-2.984	<0.001	31.8	31.2-32.3
75%-100%	3.274	3.140-3.413	<0.001	34.3	33.4-35.2
Interval between two visits					
<7	3.906	3.833-3.980	<0.001	34.6	34.2-34.9
7-14	1.915	1.886-1.945	<0.001	21.4	21.2-21.6
15-28	1.270	1.251-1.289	<0.001	15.6	15.5-15.7
29-56	1.205	1.184-1.225	<0.001	15.0	14.8-15.1
57+	(ref)			12.9	12.8-13.0
Appointment-to-visit interval, d					
<7	(ref)			10.8	10.7-10.9
7-14	1.649	1.624-1.674	<0.001	16.1	16.0-16.2
15-28	2.163	2.131-2.195	<0.001	19.7	19.6-19.9
29-56	2.205	2.164-2.248	<0.001	20.0	19.8-20.2
57+	2.537	2.495-2.580	<0.001	22.1	21.9-22.3
Weather characteristics					
Rain[c]					
No	(ref) 16.3	16.2-16.4			
Small	1.042	1.032-1.051	<0.001	16.8	16.7-16.9
Heavy	6.223	6.014-6.463	<0.001	51.1	50.3-52.0

AOR = adjusted odds ratio.

[a]Adjusted no-show rates were calculated for each factor with all other factors held at their means and expressed in percentages. Those rates were interpreted as the predicted probabilities of missed appointments if they were average in all other respects.

[b]Appointment patterns were the history of the last three appointments before the current appointment. Appointment patterns were expressed in three consecutive letters from left (the earliest appointment) to right (the last appointment) where 0 denotes no-show, 1 denotes attendance, and the underscore '_' for no history of appointment.

[c]Rain: based on the accumulative daily amount of rain in the area of the hospital.

and the previous visit to the same department was also associated with a higher no-show rate. The possible scenario could be that after treatment patients felt better and did not consider follow-ups in the short term as necessary.

In our study, the weather, especially rains, exerted a far greater influence on no-show rates than other factors did. After adjustment, the no-show rate could reach 50% in a heavy rain. Past studies had similar findings.[2,13,21] However, one other study revealed that typhoons had no significant influence on no-show rates.[19] For patients, perhaps typhoons and temperatures were more predictable than rains.

From our study results, we recommended to develop more accurate prediction models and design more appropriate interventional measures by adopting the identified factors of missed appointments. To solve the problem, some literature had proposed the method of overbooking by adding the estimated

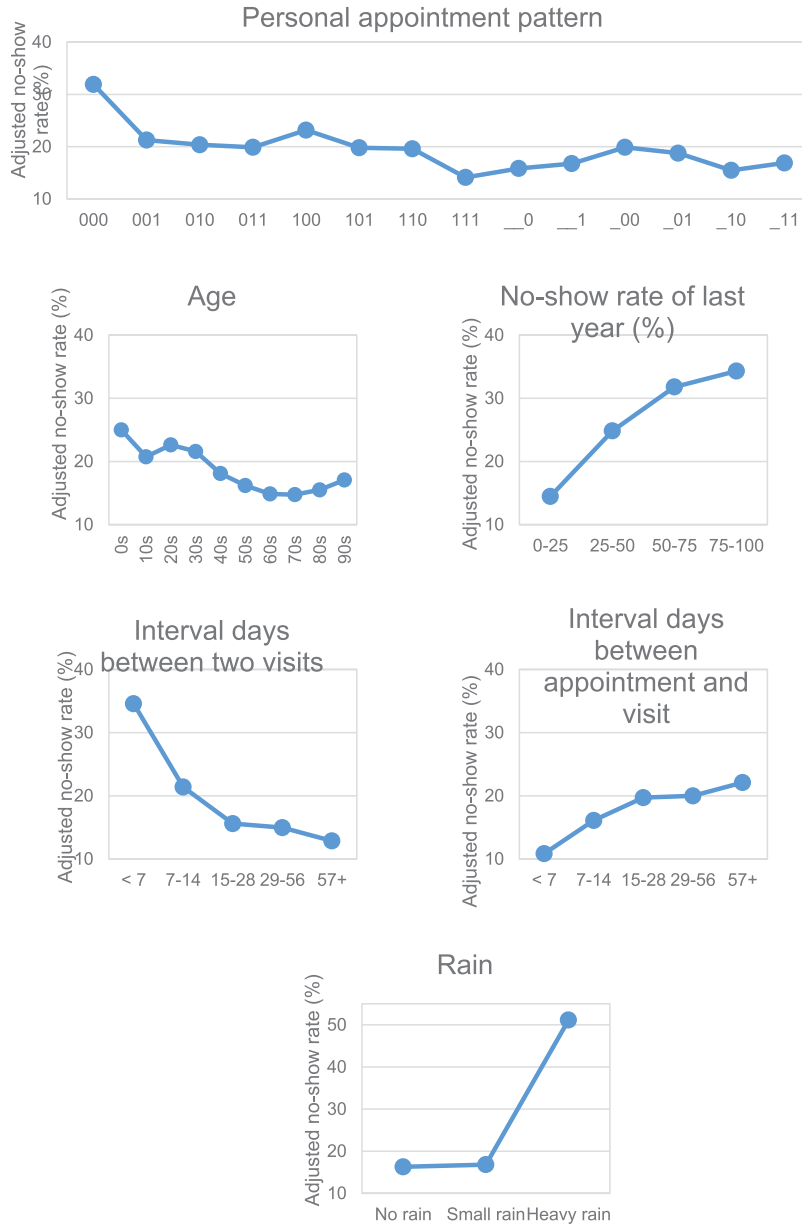

Fig. 1 Adjusted no-show rates of the most influential factors in the appointments for nonfirst visits (n = 1 767 122).

amount of missed appointments to the upper limit of reservations.[2,6,10,13,21] In case of inaccurate prediction, overbooking would prolong wait time, causing dissatisfaction and more missed appointments. It was thus essential to target habitual no-show patients.[13] While Giachetti[4] suggested a double-booking procedure in which another patient was arranged at the same time of the appointment for a habitual no-show patient, Izard[24] suggested arranging high-risk patients behind appointments for regular patients.

Our study had some limitations. First, we only analyzed the related factors of missed appointments and did not ask the patients about the causes of absence. Second, the outpatient registration files did not contain any information about physicians. The patient's address and sociocultural characteristics were not included, either. Finally, the reasons and diagnoses of visits were, unfortunately, unavailable for analysis. Third, we assumed that each patient makes each decision on attendance independently to his other appointments and analyzed our appointment at record level. Neglecting clustering effect (number of visits made by each patient) would deviate estimation on odds ratio. However, this effect should be minimal to this study because of a small repeated number made by those patients (each patient made only 5.8 visits in average). Moreover, our prediction model did not include any information regarding to contents in an appointment. The inclusion of more information such as medication, procedures, test, and surgery might probably improve prediction power theoretically but lack practical use. Because of operational reason and data protection, the aforementioned clinical information is usually unavailable for a registration system and thus cannot be used as potential predictors.

In conclusion, our study illustrated the diverse factors of missed appointments and especially identified the predictive values of rain, the interval between the appointed visit and the previous visit, and patient's personal history of missed appointments. The NHI in Taiwan offered better healthcare services in a convenient and affordable way. Yet the highly competitive environment seemed to foster missed appointments because healthcare facilities might refrain from taking restrictive measures. Developing more accurate prediction models could enhance the efficiency and quality of healthcare without sacrificing the patient's satisfaction.

ACKNOWLEDGMENTS

This study was supported by a grant from the Taipei Veterans General Hospital, Taipei, Taiwan (V107C-019).

APPENDIX A. SUPPLEMENTARY DATA

Supplementary data related to this article can be found at http://links.lww.com/JCMA/A18.

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