

Proactive Overbooking Routines Through Empiric No-show Data (PORTEND)

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Summary: Historic patient no-show data is used to predict the shifts that are likely to have a no-show. For these shifts, an extra routine appointment is added to the provider schedule with the expectation that there will probably be a no-show.

Abstract: No-shows adversely impact access. No-shows increase the net loss and decrease schedule utilization. ASQ score is affected as other members could have filled that missed appointment slot. Automatically adding an extra patient to every provider to compensate for the anticipated no-shows leads to decrease in provider morale and potential burnout. From historic West Covina clinic data, approximately 60% of any given shift will result in a least one no-show. Using historic patient data, a simple method with an 80% positive predictive value (20% sensitivity) was devised to predict the shifts that will have at least one no-show. In theory, for these shifts, an additional appointment is added with the expectation that there will be a no-show. This will help blunt the impact of no-shows. The method was validated with 6 month retrospective data for the Baldwin Park family medicine department.

Background:

No-shows adversely impact access. No-shows increase net loss and decrease schedule utilization. ASQ score is affected as other members could have filled that appointment slot. A previous published study¹ showed that there are several factors that determine the risk for an individual patient to no-show. One of these factors is the historic no-show rate for that patient. Other factors included age, gender, race, and population sector. That study proposed a complex equation that estimates the no-show risk for a patient. This study examines the effect of member historic no-show rate on the probability of at least one no-show for the shift. Additional factors could potentially include the number of routine appointments, day of the week, and timing of appointment (morning vs afternoon, proximity to holidays). Some of these items can be studied further using the data obtained to further improve on the predictions. Predicting no-shows can allow overbooking to compensate for expected no-shows, thus allowing more members to be accommodated with appointments. In theory, this would improve access and decrease appointment wait times.

Method Development

A Teradata query was constructed to obtain 6 months (Jan 1 - June 24, 2013) of appointment data from the West Covina MOB (Tables 1 and 2). For each member with a routine appointment, the member's PCP no-show data was obtained. This is the number of no-shows with their primary care provider (PCP) divided by the total number of appointments kept with their PCP prior to the appointment date. The data was imported into a Microsoft Excel file for further data manipulation. The data was collated into the individual shifts for each provider. Data from 31,473 appointments was collected. West Covina has an overall individual no-show rate of 12.7% for routine appointments and 9.34% for same-day appointments. For any given shift with at least one routine appointment, there is a 59.4% chance of having at least one no-show. From this data, a number was calculated for each shift with at least 1 routine appointment using 4 different methods. These 4 methods were compared and modified to improve predictions.

Method 1. No-show Rate Sum Method

For each shift, the individual PCP no-show rate is summed to determine the value for the no-show rate sum method. The thought is that if you have three members each with a 33% no-show rate, you can probably assume that there will be at least one no-show. This is a simplistic approach which is not the same as the probability. A single member with a 77% prior no-show rate, will automatically push the value above threshold. This method places a higher weight on the individuals. Members without any prior no-shows and new members are automatically not considered as their historic no-show rate is 0%. The positive predictive value was further improved by eliminating the shift where members had less than 6 historic visits.

Method 2. Adjusted No-Show Rate Method

For each shift, the average PCP no-show rate for the shift is determined by taking all of the prior PCP appointments No-shows and dividing by the total prior PCP appointments. This number is then multiplied by the number of routine appointments. This is another simplistic method that provides an output that does not approximate actual no-show

percentage. Members with a large number of prior appointments get greater weight, which ends up being disadvantageous for this method.

Method 3. Exponential Method

For each shift, the average PCP no-show rate for the shift is determined by taking all of the prior PCP appointment No-shows and dividing by the total prior PCP appointments. This gives the actual theoretical probability based on the historical no-show rate of the patients scheduled. As with the Adjusted No-show rate method, single members with large number of prior appointments will skew the output, thus decreasing the effectiveness of this method.

Method 4. Adjusted Exponential method

This is similar to the exponential method above, however members with no prior no-shows are excluded. This reduces the exponential factor (number of appointments for the shift), and helps to reduce the false positive rate. Also, shifts with less than 6 historical appointments are automatically excluded.

After manipulating the methods and data, some basic cutoff values were considered and it became clear that the adjusted exponential method and the No-show rate sum provided the maximal added appointments while maintaining a positive predictive value (PPV) at around 80% (Table 3). Methods 1 and 4 provided the most added appointments with a PPV of 80%.

The Teradata query was modified to automate much of the calculations and it was applied to the entire Baldwin Park Family Medicine department for Jan 1-Jun 30, 2013. For each shift, the output values of these methods are calculated. Also collected was the number of no-shows and the number of patients were actually seen during the shifts. The output is sorted from lowest to highest. The data was placed in an Excel spreadsheet. With the data sorted, the cutoff value was determined for methods 1 and 4 where the positive predictive value (PPV) reaches 79.5%. The goal is to maximize the number of shifts that achieve threshold (more added appointments) while still maintaining the 80% PPV. From this point forward, method 1 was modified to eliminate shifts where there were fewer 6 historical appointments. This improved the PPV. Also considered is the percentage of "overfilled" shifts where 11 patients are seen and there are no no-show. In these "overfilled shifts," the provider would have ended up seeing 12 patients. This percentage was 7.6% for shifts meeting the threshold. The no-show sum method seemed to give the greatest number of shifts while maintaining a near 80.0% PPV with a 30.8% sensitivity. For the same number of added appointments (2895) the adjusted exponential method yields a PPV of 79.7%. Since the No-show sum has a slightly better PPV for the same number of added appointments, it was arbitrarily chosen to be utilized for predictions. The cutoff value was determined to be about 0.77 for an 80% PPV. By increasing the cutoff value, you might get an improvement in PPV at the expense of decreased number of shifts meeting threshold (thus fewer added appointments). The practical application is that for shifts that meet the threshold, a single additional bookable routine appointment slot will be added proactively. One can theorize that it is possible to predict with an 80% PPV which shifts will have at least one no-show.

Validation

Retrospective data involved looking at the routine appointments. Routine appointments were defined as appointment being booked at least 2 days ahead of the appointment time. In an ideal setting, the data prediction would be done on a daily basis for the shifts coming up in 2 days and appointments would be added prospectively. The reality would be that those shift would be unlikely to be booked as a routine and be relegated to Same-Day use. The Same-Day appointments may go unutilized if access is good. So it is suggested that a routine appointment be added. For practical application, a once per week prediction method would be used where the predictions for upcoming week are made on the Friday prior. This would allow time for the routine appointment to be booked. The question is whether a Friday prior prediction for the upcoming week will still hold. The Teradata query was modified to look specifically at this question.

The two models were compared, "Friday prior" versus the "2 days prior" predictions (Table 5). When using the same cutoff value, with the "Friday prior" model there is a slight increased PPV rate at the expense of decreased number of added appointment (sensitivity). This is to be expected. Increased time interval to the appointment date allows for additional appointments to be booked, which increases the chance of a no-show. Because there are fewer appointments pre-booked, there will be fewer shifts that meet threshold. Member cancellations may drop shifts below

threshold resulting in an increased 'overfilled' rate. Provider cancellations would remove the added appointments. Making the calculations closer to the appointment date will likely improve accuracy and increase the number of shifts that meet threshold, but it might not be practical.

The selected method (No-Show Rate Sum) was applied retrospectively to data for the Baldwin Park Family Medicine department for 12 months (July 1, 2012-June 30, 2013). For practicality, only the routine appointments booked before the prior Friday were considered when calculating the output. The output was divided into group intervals of 0.01 and 0.25 and graphed (Tables 6 and 7). There is a clear correlation between the output values of the method and the positive predictive value. A cutoff of 0.77 gives a PPV of about 80% and would pick up approximately 25% (Sensitivity) of all the shifts with a no-show.

The selected method (No-Show Rate Sum) was applied retrospectively to data for the Baldwin Park Family Medicine for 6 months (Table 8). Again, only the routine appointments booked before the prior Friday were considered when calculating the output. Using the cutoff of 0.77, 1714 shifts (out of 9731 shifts with at least 1 routine visit prescheduled) met threshold and that many appointments would have been added over this time period. This equates to about 171 provider shifts (10 appointments per W). The total number of no-shows during this time is 10666. By adding 1714 appointments, the no-show impact is blunted by 16% (1714/10666). The number of these shifts with at least one no-show was 1400. The PPV of prediction was 81.7% (1400/1714). The overall sensitivity was 20.2% (1400/6929). The sensitivity was 23.2% (1400/6029) for shifts with at least 1 routine appointment. There would only be a small increase in percentage of total appointments 1.5% (1714/115400). Considering only routine appointments the increase is 4% (1714/42793). The vast majority (81.7%) of these appointments are being added when a patient did not show during the shift. Lowering the cutoff value would result in more appointments being added at the expense of decreased PPV. Decreased PPV would result in more false positives leading to more overfilled shifts where providers are seeing 12 or more patients. The cutoff could be decreased to 0.73, resulting in 1891 added appointment with an overall PPV of 81.4%. The PPV for the shifts with outputs 0.720 - 0.729 drops to 70%. Whereas, the 0.730-0.739 range had a PPV of 77%. Increasing the cutoff to 1.08 would result in an approximate PPV of 85%, but this would result in only 808 shifts meeting the threshold. The doubling of added appointments can justify the slight decrease in PPV. The cutoff of 0.77 seemed to work well for each of the time periods studied.

Of the 1714 shifts meeting threshold, 61 of those shifts had 12+ patients seen (Table 9). This typically means that all patients showed up and the Same Day overbook slot was utilized. Had a routine appointment been added, the overbook slot would have been taken up already and the shift would still end up with the same number of patients seen. That extra patient would have been diverted to another provider with an overbook slot available. Of the shifts meeting threshold, 7.1% (122/1714) of those shifts had 11 patients seen and zero no-shows. For these shifts, 12 patients would have been seen and this would be considered a 'overfilled shift' as a result of the add-on. A percentage of these add-ons would be expected to no-show which would result in a lower actual 'overfilled' shift rate.

Prospective validation still needs to be carried out. Each Friday, the report would be run for the upcoming week. Appointments will be added for shifts that meet the threshold. The percentage of these worked shifts with a no-show will determine the measured positive predictive value. If that measured PPV value is near 80%, then this method would be validated. The Teradata query can easily be modified to test other departments for additional historic validation.

Barriers

The primary expected barrier comes from the provider. In the private world, providers are compensated based on the number of patients seen. In the Kaiser Permanente system, there is no direct incentive for providers to see extra patients. Providers are rewarded with extra time when a member does not show up to their appointment. Having additional appointments added to the schedule does increase the daily workload. This is expounded when every scheduled appointment shows. Perhaps an incentive/compensation method can be created for those providers who end up seeing 12+ patients with the add-on. Direct financial incentives can be considered, but that would involve a change to the W system currently in place. One suggestion is for that provider to have an appointment slot held on day where access is expected to be good. The access award also does provide an indirect incentive.

Conclusion

Using historical no-show data, a method was developed to identify the shifts that are high risk for having at least one no-show with an 80% positive predictive value. For these shifts, an additional appointment can be proactively added to the provider schedule. Additional appointment supply is generated to blunt the effect of no-shows. The theoretical result is improved access and improved schedule utilization. Actual implementation would need to be done to see if the additional supply will improve access scores.

References:

1. Alaeddini et al (2011) A Probabilistic model for predicting the probability of no-show in hospital appointment. Alaeddini et al. Health Care Manag Sci (2011) 14:146-157

Tables

Table 1. West Covina 6 month historical data. Jan 1-Jun 24, 2013

	Appts				Noshows			NoShowRate		
	Routine	SameDay	Total		Routine	Sameday	Total	Routine	Sameday	Total
AM	10307	7494	17801	AM	1300	322	1622	12.6%	4.3%	9.1%
PM	5711	7961	13672	PM	856	461	1317	15.0%	5.8%	9.6%
Total	16018	15455	31473	Total	2156	783	2939	13.5%	5.1%	9.3%

Table 2. West Covina 6 month historical data Jan 1-Jun 24, 2013

	At least 1 routine appointment		Same Day Only Schedules	
	W with at least one NoShow/Ws	W NoShow Rate	W with at least one NS/Ws	W NoShow Rate
AM W	1048/1721	0.609	13/43	0.302
PM W	756/1219	0.620	114/273	0.418
Total	1804/2940	0.614	127/314	0.40

Table 3 Cutoff Value to obtain 80% positive predictive value. West Covina 6 Months

Method	Cutoff Value	Number of Added Appointments	Sensitivity	Overfill Rate
No Show Sum	0.77	773	26.3%	0.146
Adjusted No Show	0.97	415	14.1%	0.128
Exponential	0.65	531	18.1%	0.126
Adjusted Exponential	0.47	862	29.3%	0.142

Table 4 Cutoff Value to obtain 80% positive predictive value. Baldwin Park 6 Months

Method	Cutoff	Number of Added Appointments	Shifts with No-shows	PPV	Sensitivity
No Show Sum	0.77	2895	2315	80.0%	30.8%
Adjusted Exponential	0.52	2642	2118	80.2%	28.2%

Table 5 Comparing Friday Prior vs 2 Day Prior using No Show Sum method. Baldwin Park 6 Months

	Cutoff	Number of Added Appointments	Shifts with No-shows	PPV	Sensitivity
Friday Prior	0.77	2184	1771	81.1%	23.6%
2 Day Prior	0.77	2895	2315	80.0%	30.8%

Table 6. Baldwin Park Family Medicine 7/1/2012-6/30/2013

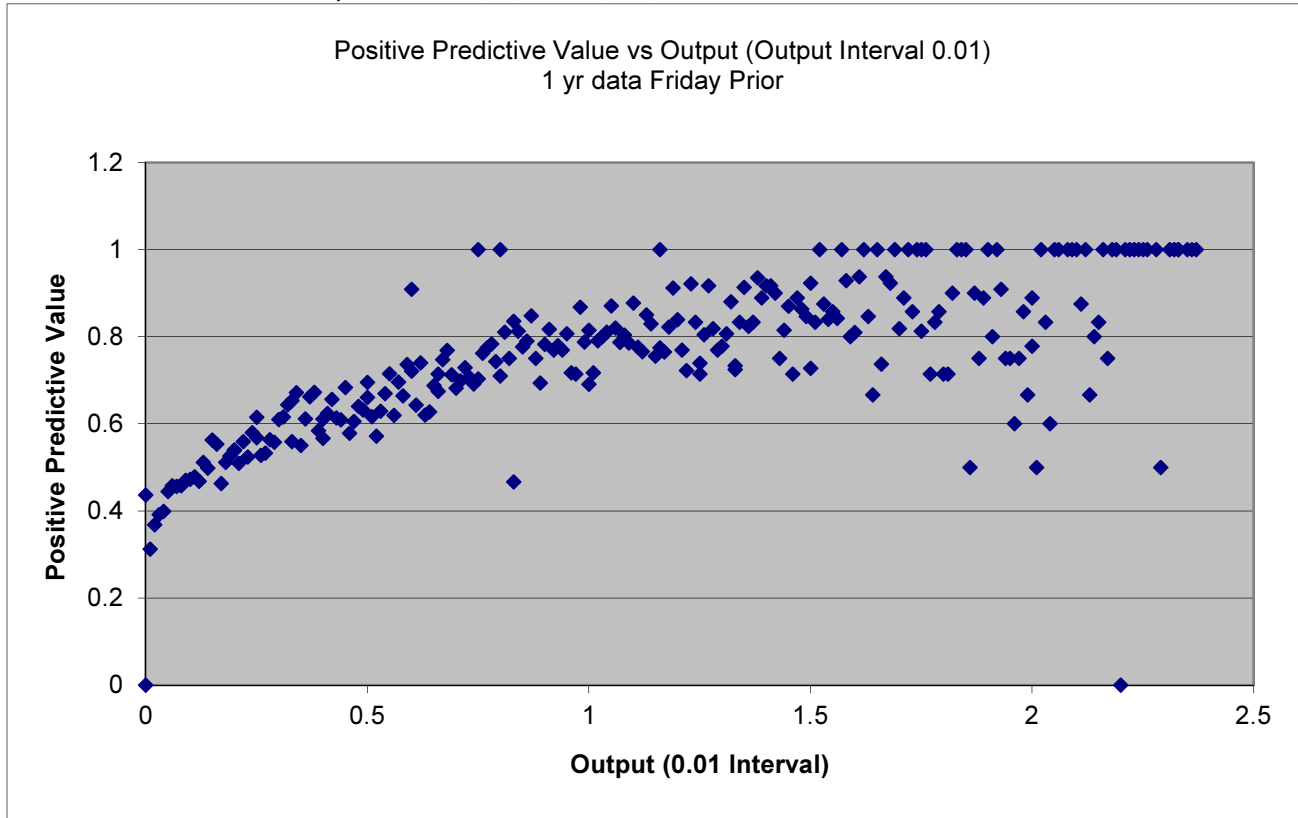


Table 7. Baldwin Park Family Medicine 7/1/2012-6/30/2013

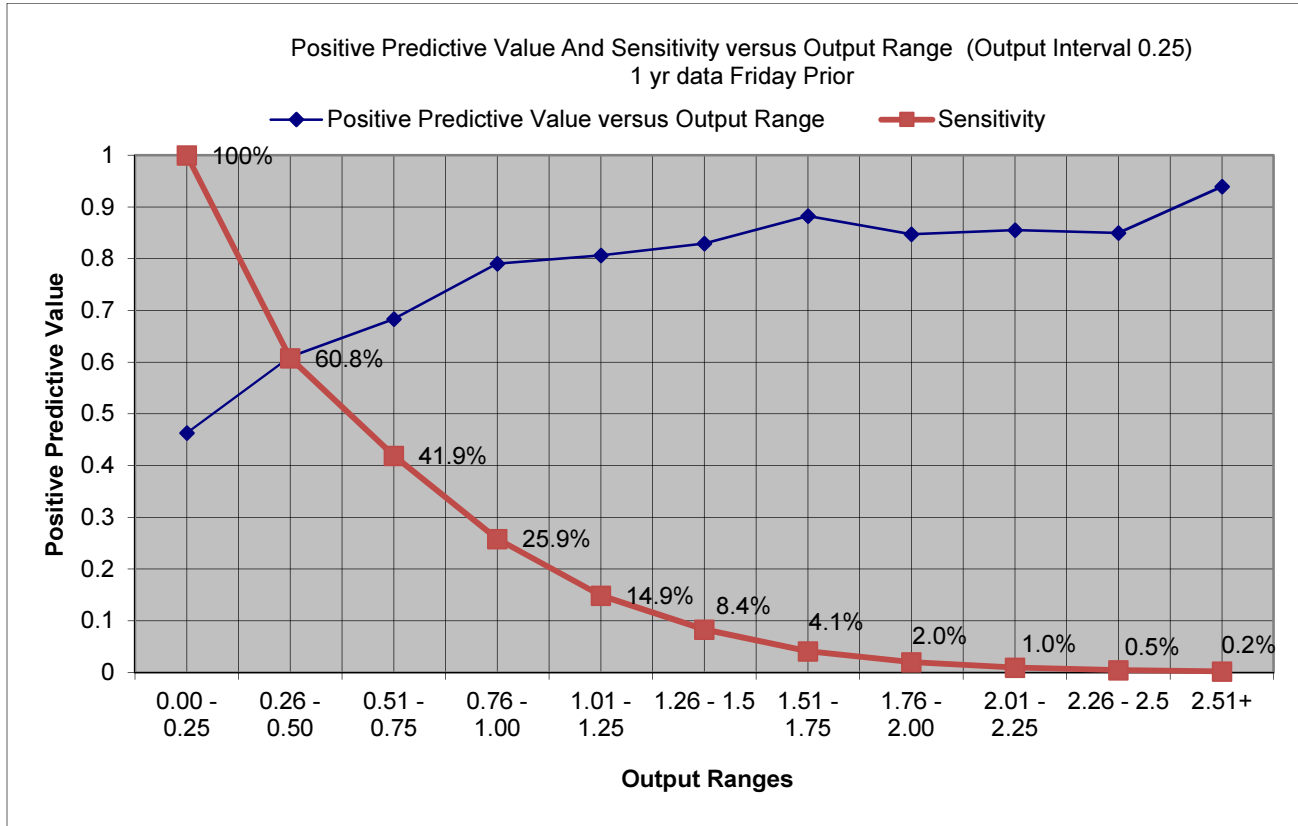


Table 8. Friday Prior Baldwin Park Jan 1-June 30, 2013

	Total Shifts	Num shifts with a no-show	% of shift with NoShow
All Shifts	11828	6929	58.6%
Same Day Shifts	2097	900	42.9%
Routine Shifts	9731	6029	62.0%
Shifts meeting Threshold ¹	1714	1400	81.7%
Routine Shifts Not meeting Threshold	8017	4629	57.7%

¹Threshold of 0.77 by No-show Sum method

Table 9. Overfilled Shift Rates Baldwin Park Jan 1-June 30, 2013

	Overfilled Shift Rates
Number of this shifts with 11 pt seen and 0 no-shows	7.1% (122/1714)
Percentage of shifts meeting threshold with 12+ pts seen	3.6% (61/1714)
Percentage of total shifts with 12+ pts seen	4.3% (504/11828)

Appendix

Terradata Query Definitions

ApptDate - Date of the appointment. Facilitates sorts within Excel

W - The shift with Provider, ApptDateDate, AM/PM

Weekof - the Monday of the week.

routinesscheduled - Total number of Routines scheduled for that shift

WRHNS - Total number of Routines scheduled where the member has at least one historical no-show

WHistNSall - Sum of all the Historic No-Shows

WHistTall - Sum of all the Historic PCP appointments

WHistNS - Sum of all the Historic No-Shows where members have at least one historical no-show

WHistT - Sum of all the Historic PCP appointments where members have at least one historical no-show

Output1 - Output of the No-show Sum method.

Output1a - Output of the No-show sum method with elimination of shifts with less than 6 historical appointments (WHistT)

Addon77 - Value is 1 if the shift meets the 0.77 threshold. These are the shifts that would get an add-on

True77 - Value is 1 if the shift meets the 0.77 threshold and there is at least one actual no-show. Averaging this column will provide the Positive predictive value.

WHNS - actual number of No-shows in the shift

WHasNS - Value is 1 if there is at least one no-show in the shift

WAppts - Actual number of appointments

WSeen - Number of patients seen that shift (calculated only if the apt date has passed.)

Terradata Query

```
select
    max(appt_date) as ApptDate,
    tablea.W,
    max(tablea.priorfriday)+3 as weekof,
    sum(isroutine) as routinesscheduled, sum(adjustednoshowcount) as WRHNS,
    sum(tablea.apptnoshow*isroutine) as WHistNSall, sum(tablea.totalappt*isroutine) as WHistTall,
    cast(sum(tablea.adjustedapptnoshow) AS decimal(9,3)) as WHistNS , sum(adjustedtotalappt) as WHistT,

    cast(sum(tablea.pcpnoshowrate*tablea.isroutine)/100 AS DECIMAL(9,3)) as output1,

    case WHEN WHistT < 6 then 0
    else cast(sum(tablea.pcpnoshowrate*tablea.isroutine)/100 AS DECIMAL(9,3))
    end as output1a,

    case WHEN output1a < 0.77 then 0
    else 1
    end as addon77,

    addon77*WHasNS as true77,

    sum(isnoshow) as WNS,
    max(isnoshow) as WHasNS,
```

```
count(W) as WAppts,  
(WAppts - WNS)*max(Wispast) as WSeen
```

```
FROM  
  
(SELECT ser.PROV_NAME, ser.PROV_ABBR, enc.DEPARTMENT_ID, enc.PAT_ID, enc.APPT_TIME, enc.APPT_MADE_DATE, enc.ENC_TYPE_C, enc.APPT_STATUS_C,  
  
cal.day_of_week as dayofweek,  
  
(CONTACT_DATE - dayofweek - 1) as priorfriday,  
  
/*case WHEN enc.APPT_MADE_DATE < (CONTACT_DATE - dayofweek - 1) then 1 /* Friday before */  
  
case WHEN enc.APPT_MADE_DATE < CONTACT_DATE - 1 then 1  
  
else 0  
end as isroutine,  
  
case WHEN date > CONTACT_DATE and enc.ENC_TYPE_C = 50 then 1  
else 0  
end as isnoshow,  
  
(SELECT count(APPT_STATUS_C) from PAT_ENC enc4  
WHERE enc4.PAT_ID = enc.PAT_ID AND (enc4.ENC_TYPE_C = 50 OR enc4.ENC_TYPE_C = 101) AND enc4.PCP_PROV_ID = enc4.VISIT_PROV_ID AND enc4.APPT_STATUS_C = 4 AND  
enc4.CONTACT_DATE < enc.CONTACT_DATE) as apptnoshow,  
  
( SELECT count(APPT_STATUS_C) from PAT_ENC enc2  
WHERE enc2.PAT_ID = enc.PAT_ID AND (enc2.ENC_TYPE_C = 50 OR enc2.ENC_TYPE_C = 101) AND enc2.PCP_PROV_ID = enc2.VISIT_PROV_ID AND enc2.APPT_STATUS_C = 2 AND  
enc2.CONTACT_DATE < enc.CONTACT_DATE) as apptcomplete,  
  
(apptnoshow + apptcomplete) as totalappt,  
  
ROUND(apptnoshow*100/(totalappt+ 0.0001),1) as pcpnoshowrate,  
  
CASE WHEN apptnoshow = 0 then 0  
else totalappt * isroutine  
end as adjustedtotalappt,  
  
CASE WHEN apptnoshow = 0 then 0  
else apptnoshow*isroutine  
end as adjustedapptnoshow,  
  
CASE WHEN adjustedapptnoshow > 0 then 1  
else 0  
end as adjustednoshowcount,  
  
extract(hour from enc.APPT_TIME) as hr,  
  
case when hr < 13 then 'AM'  
else 'PM'  
end as ampm ,  
  
trim(extract(year from enc.APPT_TIME)) as yr,  
case when trim( extract(month from enc.APPT_TIME)) > 9 then trim( extract(month from enc.APPT_TIME))  
else '0' || trim( extract(month from enc.APPT_TIME))  
end as mo,  
Case when trim(extract(day from enc.APPT_TIME)) > 9 then trim(extract(day from enc.APPT_TIME))  
else '0' || trim(extract(day from enc.APPT_TIME))  
end as dy,  
  
ser.PROV_ABBR || '-' || yr || '-' || mo || '-' || dy || '-' || ampm as W,  
  
yr || '-' || mo || '-' || dy as appt_date,  
  
case when CONTACT_DATE > date - 1 then 0  
else 1  
end as Wispast  
  
FROM PAT_ENC as enc  
LEFT OUTER JOIN CLARITY_SER as ser  
on ser.PROV_ID = enc.VISIT_PROV_ID  
LEFT OUTER JOIN EMP_MAP as p  
on p.CID = ser.USER_ID  
LEFT OUTER JOIN sys_calendar.calendar as cal  
on calendar_date = CONTACT_DATE  
  
WHERE /* List of Departments */  
enc.DEPARTMENT_ID IN  
(  
'1504965',  
'1504966',
```


'1201702270065',
'1201702270082',
'1201702270090',
'1201702300020',
'1201702300028',
'1201702300031',
'1201702320002',
'1201702320005',
'1201702350014',
'1201702350017',
'1201702350019',
'1201702350020',
'1501702320022'
)

AND enc.CONTACT_DATE BETWEEN '01/01/2013' and '06/30/2013' /*Study period can be Future or Past */

/*AND enc.APPT_MADE_DATE < enc.CONTACT_DATE -1 /* Appt is booked at least 2 days before */

AND (enc.ENC_TYPE_C = 50 OR enc.ENC_TYPE_C = 101) /* Appt (50) or Office Visit (101) */

AND (enc.APPT_CANCEL_DATE is NULL) /*Appt was not cancelled */

AND enc.VISIT_PROV_TITLE <> '12011' /*exclude LVN*/

AND enc.VISIT_PROV_TITLE <> '12012' /*exclude MA*/

AND enc.VISIT_PROV_TITLE <> '12021' /*exclude RN*/

AND enc.VISIT_PROV_TITLE <> '12015' /*exclude NP*/

AND enc.VISIT_PROV_TITLE <> '12028' /*exclude PA*/

) tablea

GROUP BY tablea.W

ORDER BY addon77, output1a