

# Predictors of missed appointments in patients referred for congenital or pediatric cardiac magnetic resonance

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## Abstract

**Background** Congenital cardiac magnetic resonance is a limited resource because of scanner and physician availability. Missed appointments decrease scheduling efficiency, have financial implications and represent missed care opportunities. **Objective** To characterize the rate of missed appointments and identify modifiable predictors. **Materials and methods** This single-center retrospective study included all patients with outpatient congenital or pediatric cardiac MR appointments from Jan. 1, 2014, through Dec. 31, 2015. We identified missed appointments (no-shows or same-day cancellations) from the electronic medical record. We obtained demographic and clinical factors from the medical record and assessed socioeconomic factors by U.S. Census block data by patient ZIP code. Statistically significant variables ( $P < 0.05$ ) were included into a multivariable analysis.

**Results** Of 795 outpatients (median age 18.5 years, interquartile range 13.4–27.1 years) referred for congenital cardiac MR, a total of 91 patients (11.4%) missed appointments; 28 (3.5%) missed multiple appointments. Reason for missed appointment could be identified in only 38 patients (42%), but of these, 28 (74%) were preventable or could have been identified prior to the appointment. In multivariable analysis, independent predictors of missed appointments were referral by a non-cardiologist (adjusted odds ratio [AOR] 5.8,  $P = 0.0002$ ), referral for research (AOR 3.6,  $P = 0.01$ ), having public insurance (AOR 2.1,  $P = 0.004$ ), and having scheduled cardiac MR from November to April (AOR 1.8,  $P = 0.01$ ).

**Conclusion** Demographic factors can identify patients at higher risk for missing appointments. These data may inform initiatives to limit missed appointments, such as targeted education of referring providers and patients. Further data are needed to evaluate the efficacy of potential interventions.

**Keywords** Cardiac magnetic resonance · Children · Congenital heart disease · Missed appointments · Pediatric cardiology · Resource utilization

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## Introduction

Cardiac magnetic resonance is an essential tool for evaluation of pediatric and congenital heart disease. Because of its utility in evaluating vascular anatomy such as pulmonary arteries and the aortic arch, accurately and reproducibly quantifying ventricular function, and assessing physiology and flow measurements, cardiac MR plays a prominent role in recent guidelines for multimodality imaging and follow-up evaluation [1–3]. However congenital cardiac MR is also a limited resource, requiring scanner availability as well as physician expertise [4–6] for real-time monitoring during image

acquisition because of the diversity of surgical repairs and clinical questions.

A number of barriers to scheduling MRI studies have been identified, often resulting in long waiting lists [7]. In this context, missed appointments (no-show, late reschedule and cancellations) decrease scheduling efficiency and represent missed opportunities for patient care, in addition to lost revenue. Socioeconomic rather than medical factors have been shown to be the primary driver of same-day cancellations in other types of pediatric MRI studies [8], but data are not available for congenital cardiac MR studies.

The researchers in this study aimed to determine the rate of missed appointments for congenital cardiac MR studies, and to identify potentially modifiable predictors that could be targeted in process-improvement initiatives.

## Materials and methods

The institutional review board approved this study and waived the requirement for informed consent.

This single-center retrospective study included all patients with outpatient congenital or pediatric cardiac MR appointments at our institution from Jan. 1, 2014, through Dec. 31, 2015. Within the study period, outpatient cardiac MR studies were performed at either the children's hospital or an adult outpatient facility, with a limited number of slots per week available for congenital studies. The children's hospital is in close proximity to other subspecialty care centers; the adult outpatient facility is off-site but has free parking available. Patients with more complicated anatomy or requiring sedation were scheduled at the children's hospital. We excluded inpatient cardiac MR appointments from this analysis because reasons for late cancellation were more likely to be related to change in clinical status and not relevant to the larger outpatient population. Missed appointments were defined as no-show, same-day cancellation, or appointments that were re-scheduled on the day of cardiac MR. Cardiac MR studies that could not be completed as a result of claustrophobia were not included as missed appointments. We identified missed appointments by searching the electronic medical record for cancelled cardiac MR appointments on scanners used for pediatric and congenital studies. We then confirmed the date of cancellation, including only same-day cancellations, and compared the remaining cancelled appointments to scheduling records and an institutional clinical database to confirm whether these were outpatient pediatric/congenital studies, and whether the study was in fact performed or rescheduled.

During the study period, the process of scheduling a cardiac MR study began with a request from the referring physician, at which time a questionnaire was completed, including potential exclusions for cardiac MR (e.g., claustrophobia, implants). A scheduler within the Division of Pediatric Cardiology would contact the patient or family to arrange an

appointment at either the children's hospital or the adult outpatient facility (if 14 years or older). If the patient or family wished to cancel or reschedule an appointment, calls could be made to either the Pediatric Cardiology or Radiology call centers. During the study period, no specific interventions had been initiated to prevent missed appointments. As for all clinical appointments at our center, an automated phone call and reminder letter were provided prior to each appointment.

The reason for a missed appointment was identified from scheduling comments, notes in the institution-specific clinical database (which tracks cardiac MR studies, indications and findings), or clinic notes, whenever possible. The reason was classified as preventable or modifiable if it could be targeted by initiatives to limit missed appointments or if early recognition (prior to the scheduled date) could have enabled a more appropriate scheduling.

Potential predictors of missed appointments were identified a priori, and included age, gender, socioeconomic status, public insurance (Medicare/Medicaid) vs. private, distance from the patient's home to the hospital, completion of prior cardiac MR, indication for cardiac MR, referring physician, cardiac MR site (children's hospital or outpatient adult facility), season, requirement for sedation, and referral for a research study. Clinically indicated cardiac MR studies that were also included in a research study were not included as referred for research. All designated research studies are scheduled on our clinical scanners during dedicated cardiac MR imaging blocks. Socioeconomic status was represented by household income and patient/parent education, which was based on U.S. Census block data by patient ZIP code. All other data were obtained from the clinical database or by chart review. Season of cardiac MR was dichotomized as November to April (to represent respiratory virus season) and May to October. More granular analysis of timing was not feasible because of sample size.

Data are presented as frequency (percentage) or median (interquartile range [IQR]). Categorical variables were compared by chi-square test or Fisher exact test. Continuous variables were compared by Wilcoxon rank sum test. Univariate and multivariable logistic regression were used to identify factors associated with having missed appointments. Factors found to be significantly associated with missed appointments on univariate analysis ( $P < 0.05$ ) were included in a multivariable analysis. Unadjusted and adjusted odds ratios with 95% confidence intervals from the logistic regressions are reported. All analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC). A  $P$ -value  $< 0.05$  was considered statistically significant.

## Results

During the study period, 795 patients had an outpatient cardiac MR appointment. Demographics and clinical characteristics are

presented in Table 1. The vast majority were referred by a cardiologist, typically from the same institution.

A total of 91 patients (11.4%) missed appointments, with 28 (3.5%) missing multiple appointments. The reason for the missed appointment could be identified in 38 patients (41.8%). Of the identified reasons, most were preventable or modifiable (31, 81.5%). Scheduling issues were identified in 12 patients (conflict with another appointment in 6, not scheduled with sedation in 4, not coordinated with other appointment in 1, and scheduling error in 1). Preventable or

modifiable patient issues were found in 14 (5 patients had transportation issues, 3 patients had insurance issues, 2 patients forgot the appointment, 1 patient arrived late, 1 patient got lost, 1 patient moved, and 1 patient was pregnant). Referral errors led to missed appointments in 5 patients (no longer clinically necessary in 4, and contraindication to cardiac MR in 1). Non-preventable issues were found in 7 patients (illness in 6 and equipment failure in 1). Of those with missed appointments, 53 patients (58.2%) did eventually complete a cardiac MR study, a median of 60 days after the missed appointment (IQR 29–107 days).

**Table 1** Demographics and clinical characteristics in patients referred for cardiac magnetic resonance imaging (n=795)

Male gender <sup>a</sup>	453 (57.0)
Age at cardiac MR appointment, years <sup>b</sup>	18.5 (13.4–27.1)
Prior completed cardiac MR <sup>a</sup>	276 (34.7)
Distance from hospital, miles <sup>b</sup>	43 (22–91)
Insurance <sup>a</sup>	
Public only	205 (25.8)
Private only	476 (59.9)
Both public and private	107 (13.5)
Unknown	7 (0.9)
U.S. Census block data <sup>b</sup>	
Median household income, \$	52,958 (43,565–67,463)
High school graduate, %	92.0 (88.5–94.4)
College graduate, %	26.0 (17.2–39.6)
Primary indication for cardiac MR <sup>a</sup>	
Tetralogy of Fallot	170 (21.4)
Aortic arch obstruction	94 (11.8)
Cardiomyopathy	94 (11.8)
Single ventricle physiology	67 (8.4)
Aortic dimensions	48 (6.0)
Pulmonary stenosis/pulmonary insufficiency	46 (5.8)
D-looped transposition of the great arteries	42 (5.3)
Other	234 (29.4)
Referring physician <sup>a</sup>	
Physician from the same institution	690 (86.8)
Cardiologist	772 (97.1)
Adult cardiologist (if patient >18 years old)	234/406 (57.6)
Scheduled with anesthesia <sup>a</sup>	156 (19.6)
Referral for research study <sup>a</sup>	31 (3.9)
Site <sup>a</sup>	
Children’s hospital	558 (70.2)
Outpatient adult facility	234 (29.4)
Adult hospital	3 (0.4)
Season <sup>a</sup>	
November to April	333 (41.9)
May to October	462 (58.1)

<sup>a</sup> Data are presented as n (%) for categorical variables

<sup>b</sup> Data are presented as median (interquartile range) for continuous variables

Factors associated with missed appointments on univariate analysis are presented in Table 2. Patient/parent level of education ( $P=0.12$  for high school graduate and  $P=0.38$  for college graduate), being scheduled with sedation/anesthesia ( $P=0.42$ ), and having completed a prior cardiac MR ( $P=0.89$ ) were not associated with having missed appointments. On multivariable analysis, having public insurance, scheduled cardiac MR from November to April, and being referred by a non-cardiologist or for a research study were independent predictors of missed appointments (Fig. 1).

In the subset of adult patients, the overall rate of missed appointments was slightly higher (53/417, 12.7%). Predictors of missed appointments on univariate analysis were similar, with the addition of age, as older adults were less likely to miss appointments (Table 3). There was a trend toward significance of having more missed appointments during November to April (16.6% vs. 10.1%,  $P=0.051$ ). On multivariable analysis, only having public insurance and referral for a research study were independent predictors of missed appointments (Fig. 2).

Compared to patients who missed a single appointment, patients with multiple missed appointments were

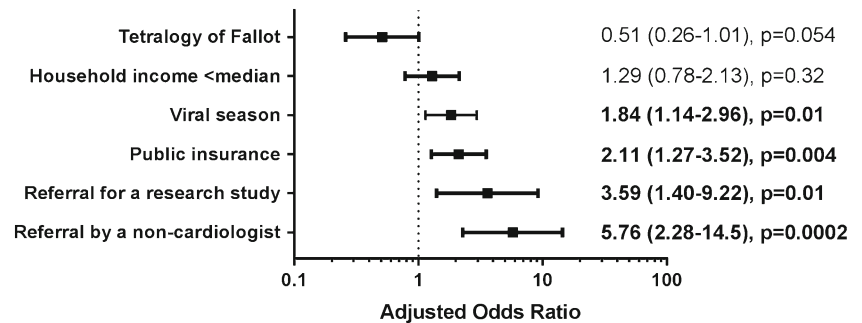
**Table 2** Factors associated with a missed appointment on univariate analysis (n=795)

Characteristics	OR	95% CI	P-value*
Public insurance	2.35	1.49–3.74	0.0002
Median household income			0.02
<\$52,958 (median)	1.72	1.11–2.72	
≥\$52,958	Ref		
Tetralogy of Fallot	0.47	0.23–0.87	0.02
Referral by non-cardiologist	9.52	4.00–22.8	<0.0001
Referral for research study	3.40	1.44–7.52	0.005
Season			0.004
November to April	1.91	1.23–2.98	
May to October	Ref		

CI confidence interval, OR (unadjusted) odds ratio, Ref reference for odds ratio calculation

\*P-value <0.05 was considered statistically significant

**Fig. 1** Independent predictors of missed appointments on multivariable analysis. Data are presented as adjusted odds ratio (95% confidence interval). Bold indicates significant values ( $P < 0.05$ )



older (median 23.4 vs. 18.2 years old,  $P=0.01$ ) and more likely to be referred by a non-cardiologist (35.7% vs. 3.2%,  $P < 0.0001$ ) or for a research study (21.4% vs. 4.8%,  $P=0.02$ ). Patients with multiple missed appointments were also more likely to be scheduled at the children's hospital (89.3% vs. 69.8%,  $P=0.046$ ). Having multiple missed appointments was associated with similar risk factors on univariate analysis to those identified in patients with one missed appointment (Table 4). There was no difference in season of cardiac MR (4.1% vs 3.7%,  $P=0.77$ ). On multivariable analysis, only referral by a non-cardiologist and referral for a research study were independent predictors of having multiple missed appointments (Fig. 3).

## Discussion

In this cohort of patients referred for outpatient pediatric and congenital cardiac MR, there was a significant rate of missed appointments (11.4% over a 2-year period). Having public insurance, having scheduled cardiac MR from November to April, and being referred by a non-cardiologist or for a research study were independent predictors of having a missed appointment, while medical factors such as indication for cardiac MR were not predictive. This is the first study to evaluate predictors of missed appointments in this population.

Although all missed appointments can place a burden on the system, congenital cardiac MR can be particularly problematic because of its already limited access. Although

physician involvement is variable by center, in our center congenital cardiac MR is performed as a collaboration between radiology and cardiology in order to improve patient care by combining the strengths and expertise of both fields. However this also increases the physician resources allocated to each study, which magnifies the problem of missed appointments. Optimizing show rates is necessary to improve productivity. Missed appointments also impact patient care, delaying time to diagnosis for patients who reschedule, as well as limiting access for other patients because rescheduled patients ultimately occupy multiple slots. Patients with multiple missed appointments thus become particularly problematic.

The rate of missed appointments was higher than the rate for missed noncardiac studies at our institution (typically <5%) but was similar to that reported for all missed MRI studies from three tertiary academic centers in the United States [9] and was substantially lower than that reported for missed MRI appointments in a study based in Saudi Arabia [10] and even missed primary care appointments in the United States [11]. Even in different populations, it is important to note that demographic factors such as lack of education or having public insurance also predicted missed appointments in these studies, suggesting that targeted education and intervention might have the potential to improve patient care and health care efficiency. The population of patients with congenital heart disease also might have particular challenges. Families of younger patients might have to manage multiple subspecialty appointments, given the high prevalence of genetic syndromes and noncardiac comorbidities [12], which might help to explain the frequency of scheduling issues in those with identified reasons for missed appointments. In the adult congenital heart disease population, lapses of care have also been identified as a significant issue [13, 14]. We found more frequent missed appointments in younger adults, who might not have transitioned care or who might have difficulty with insurance. Although we cannot account for all patients with missed appointments, particularly patients who did not ultimately complete a cardiac MR study, this is concerning because lapses of care in the adult congenital heart disease population have been associated with poor outcomes [13].

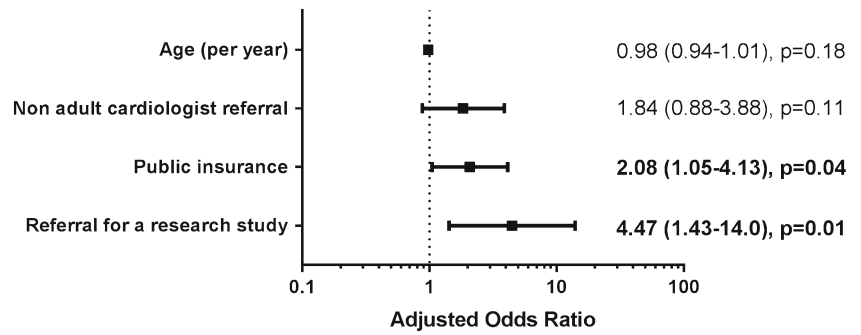
**Table 3** Factors associated with a missed appointment in patients >18 years of age on univariate analysis ( $n=417$ )

Characteristics	OR	95% CI	P-value*
Age at cardiac MR appointment, years	0.96	0.92–0.98	0.003
Public insurance	2.18	1.18–4.03	0.01
Non-adult cardiologist referral	2.48	1.32–4.78	0.004
Referral for research	5.96	2.29–15.1	0.0004

CI confidence interval, OR (unadjusted) odds ratio

\*P-value <0.05 was considered statistically significant

**Fig. 2** Independent predictors of missed appointments in patients >18 years old on multivariable analysis. Data presented as adjusted odds ratio (95% confidence interval). Bold indicates significant values ( $P<0.05$ )



**Table 4** Factors associated with multiple missed appointments on univariate analysis ( $n=732$ )

Characteristics	OR	95% CI	P-value
Public insurance	3.35	1.52–7.93	0.002
Referral by non-cardiologist	34.3	12.7–93.2	<0.0001
Referral for research study	8.40	2.86–22.3	0.0004
Site			0.03
Children’s hospital	3.61	1.25–15.3	
Outpatient adult facility	Ref		

CI confidence interval, OR (unadjusted) odds ratio, Ref reference for odds ratio calculation

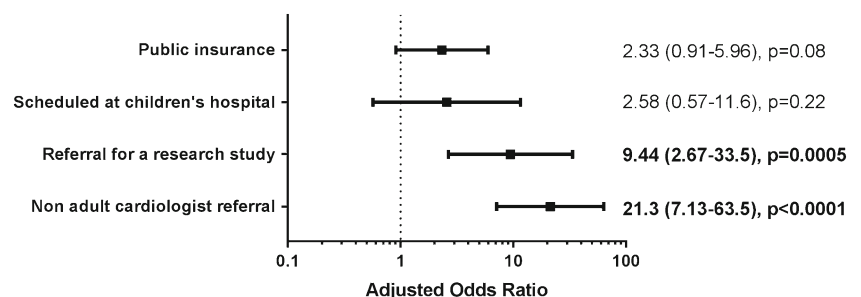
\*P-value <0.05 was considered statistically significant

This study focused on predictive factors that could be identified prior to the appointment, for targeted intervention, and did not include a true process improvement methodology to evaluate all factors that might improve the patient experience (such as convenience of parking). Thus, although not all reasons could be identified or necessarily modifiable, the factors we have identified as associated with missed appointments could inform potential interventions. Missed cardiac MR appointments during the winter are most likely related to weather or illness and this is not modifiable. However, the association between missed cardiac MR appointments and referring physician suggests that targeted education of the referring physicians could be beneficial, particularly non-cardiologists referring for congenital cardiac MR such as hematologists or adult physicians who are not necessarily aware of the limited

availability of congenital cardiac MR. Similarly, patients scheduled for a research study might be less invested because the study is often not scheduled for their own clinical benefit. Thus communication with research coordinators emphasizing the limited availability of cardiac MR appointments might help ensure that study subjects arrive as scheduled.

Although the reason for missed appointments could not be identified in all cases, the majority were related to issues that could be identified prior to the scheduled study. All patients are pre-screened at the time of scheduling, but multiple patient factors can change in the interim. The context of patient reminders could impact the likelihood of arrival. During the study period, standard protocol included an automated phone call 3 days prior to the appointment and a written reminder in the mail, identical to reminders for other tests or appointments, without further screening or cardiac-MR-specific questions. The relation of referral by a non-cardiologist to missed appointments might reflect the patient–physician relationship because patients prefer to discuss cardiac-related care with their cardiologist [15]. Alternatively, this might reflect a missed opportunity for discussion of the specifics of the study with someone familiar with the test. Live rather than automated calling systems have been shown to increase patient on-time arrival [16] and can also be effective when targeted at high-risk populations [17]. Perhaps if patients were contacted by a person who could answer questions regarding the test, patients might be more receptive and responsive. Standardized questions could also be included to evaluate for changes in eligibility for cardiac MR, such as standard screening questions and evaluating for insurance or transportation issues.

**Fig. 3** Independent predictors of having multiple missed appointments on multivariable analysis. Data presented as adjusted odds ratio (95% confidence interval). Bold indicates significant values ( $P<0.05$ )





Further study is necessary to evaluate the potential impact of such interventions.

This study does have limitations. The retrospective nature of the study limits its utility in identifying potential factors that were not recorded, and not all studies had an identified reason for cancellation or rescheduling because patients can cancel or reschedule without providing reasons. Although this is a single-center study, this is a high-volume center with a broad base of patients and indications for referral.

## Conclusion

Cardiac MR is an essential but limited resource for evaluation of pediatric and congenital heart disease. Demographic factors, such as having public insurance or being referred by a non-cardiologist or for a research study, can identify patients at higher risk for missing appointments. These data might inform initiatives to limit missed appointments, such as targeted education of referring providers and patients and secondary screening for barriers to cardiac MR closer to the time of the study. Further data are needed to evaluate the efficacy of interventions to improve patient care, access to cardiac MR, and clinical productivity.

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## Compliance with ethical standards

**Conflicts of interest** None

## References

1. Valente AM, Cook S, Festa P et al (2014) Multimodality imaging guidelines for patients with repaired tetralogy of Fallot: a report from the American Society of Echocardiography developed in collaboration with the Society for Cardiovascular Magnetic Resonance and the Society for Pediatric Radiology. *J Am Soc Echocardiogr* 27: 111–141
2. Cohen MS, Eidem BW, Cetta F et al (2016) Multimodality imaging guidelines of patients with transposition of the great arteries: a report from the American Society of Echocardiography developed in collaboration with the Society for Cardiovascular Magnetic Resonance and the Society of Cardiovascular Computed Tomography. *J Am Soc Echocardiogr* 29:571–621
3. Wames CA, Williams RG, Bashore TM et al (2008) ACC/AHA 2008 guidelines for the management of adults with congenital heart disease: executive summary: a report of the American College of Cardiology/American Heart Association task force on practice guidelines (writing committee to develop guidelines for the management of adults with congenital heart disease). *Circulation* 118: 2395–2451
4. Kramer CM, Hundley WG, Kwong RY et al (2015) COCATS 4 task force 8: training in cardiovascular magnetic resonance imaging. *J Am Coll Cardiol* 65:1822–1831
5. Schulz-Menger J, Bluemke DA, Bremerich J et al (2013) Standardized image interpretation and post processing in cardiovascular magnetic resonance: Society for Cardiovascular Magnetic Resonance (SCMR) board of trustees task force on standardized post processing. *J Cardiovasc Magn Reson* 15:35
6. Fratz S, Chung T, Greil GF et al (2013) Guidelines and protocols for cardiovascular magnetic resonance in children and adults with congenital heart disease: SCMR expert consensus group on congenital heart disease. *J Cardiovasc Magn Reson* 15:51
7. Wessman BV, Moriarity AK, Ametli V et al (2014) Reducing barriers to timely MR imaging scheduling. *Radiographics* 34:2064–2070
8. Hoffman AS, Matlow A, Shroff M et al (2015) Factors impacting same-day cancellation of outpatient pediatric magnetic resonance imaging under anesthesia. *Pediatr Radiol* 45:99–107
9. Norbash A, Yucel K, Yuh W et al (2016) Effect of team training on improving MRI study completion rates and no-show rates. *J Magn Reson Imaging* 44:1040–1047
10. AlRowaili MO, Ahmed AE, Areabi HA (2016) Factors associated with no-shows and rescheduling MRI appointments. *BMC Health Serv Res* 16:679
11. Kaplan-Lewis E, Percac-Lima S (2013) No-show to primary care appointments: why patients do not come. *J Prim Care Community Health* 4:251–255
12. Massin MM, Astadicko I, Dessy H (2007) Noncardiac comorbidities of congenital heart disease in children. *Acta Paediatr* 96:753–755
13. Yeung E, Kay J, Roosevelt GE et al (2008) Lapse of care as a predictor for morbidity in adults with congenital heart disease. *Int J Cardiol* 125:62–65
14. Heery E, Sheehan AM, While AE et al (2015) Experiences and outcomes of transition from pediatric to adult health care services for young people with congenital heart disease: a systematic review. *Congenit Heart Dis* 10:413–427
15. Luthy SK, Yu S, Donohue JE et al (2016) Parental preferences regarding outpatient management of children with congenital heart disease. *Pediatr Cardiol* 37:151–159
16. Recht M, Macari M, Lawson K et al (2013) Impacting key performance indicators in an academic MR imaging department through process improvement. *J Am Coll Radiol* 10:202–206
17. Shah SJ, Cronin P, Hong CS et al (2016) Targeted reminder phone calls to patients at high risk of no-show for primary care appointment: a randomized trial. *J Gen Intern Med* 31:1460–1466