Research Article

Electronic Health Record-Embedded Automated Patient Outreach to Increase Completion of Outstanding Health Care Services

Katherine L. Liang[1,2], Eman Jammali[1,3], Yasir Tarabichi[1,4], David C. Kaelber[1,5], Anna RybiÅska-Campbell[6], Ashley M. Hughes[1,4]
Affiliation addresses are listed at the end of the article.

ABSTRACT

Background Automated patient outreach (APO) approaches offer promising solutions to patient engagement for outstanding health care services. Little is known about APO effectiveness.

Objectives This study evaluates the effect of an electronic health record (EHR)-embedded APO. We assessed how outreach modality, number of outreach attempts, patient sex, and patient age affected outreach success across various recommended health care services.

Methods We conducted a retrospective evaluation of an EHR-embedded APO at a large, academic safety-net health system located in Northeast Ohio. The APOs involved up to three outreaches via patient portal (PP), phone call (PC), or SMS message, based on patient preference. APO evaluation included outreach for specific outstanding recommended health care services: lead screening, laboratories, colorectal cancer screening, immunizations, CT scans, and ultrasounds.

Results Among 46,261 outreaches to 19,537 patients, success occurred in 23.4% of outreaches and 55.4% of patients. Success varied widely by campaign (3.2–35.2%). SMS (24.6%) outreach was associated with greater success than PP (21.6%, $p < 0.001$) and PC (20.4%, $p < 0.001$), though results differed between campaigns. Outreach conducted in the third phase (50.5%) was overall more likely to be successful than the first (13.4%, $p < 0.001$) or second (13.8%, $p < 0.001$). However, some campaigns showed the greatest successes at phase 2. Male and female patients showed small but significant differences in success (54.2 vs. 56.0%, $p = 0.016$). Patient age was strongly associated with campaign success ($p < 0.001$).

Conclusion EHR-embedded APOs are a viable method of patient outreach for outstanding health care services. SMS messaging and three outreach attempts were found to be associated with the greatest success overall. Notably, analysis of individual health care services campaigns shows patients responded differently to different campaigns with different message modes, message frequencies, and length between messages, indicating further need for research in this space. Patient characteristics, especially age, appear to be associated with campaign success, but additional study is needed.

Keywords ambulatory care/primary care, electronic health records and systems, alerting, implementation and deployment, patient–provider

received February 06, 2026 | **accepted after revision** June 20, 2026 | **article published online** 2026

Bibliography Appl Clin Inform 2026; 17: 549–558 **DOI** 10.1055/a-2900-1614 **Art ID** ACI-2026-01-RA-0042

Correspondence Katherine L. Liang, MD, Center for Clinical Informatics Research and Education, The MetroHealth System, Cleveland, Ohio 44109, United States, Email: katherine.liang@utsouthwestern.edu

Background and Significance

The U.S. patient populations are growing in complexities.[1] Estimates show that primary care providers (PCPs) would need to work 26.7 hours daily to adequately address patients' needs.[2] Between time constraints,[3,4] noted barriers to accessing primary care,[5,6] and shortages in the workforce,[7,8] delays in receiving care are common, often resulting in recommended health care services not being completed.[9–12] Timely completion of provider-recommended health care services—such as cancer screenings, vaccinations, and diagnostic testing—is critical to improving population health outcomes, enabling diagnosis, and addressing disparities in care.[13–16]

Health systems rely on population health services to increase uptake of recommended preventative and follow-up health care services, which is becoming more important as health care moves toward value-based care. These services shift ownership and responsibility of patients' follow-up from primary care to centralized, scalable processes. Among these approaches are patient navigation to overcome patient-level barriers (e.g., social determinants of health), empowering patient self-management through education and patient portal (PP) alerts, and team-based configurations of care.[17] Compared with individual provider-led efforts, systems-based efforts have been shown to be successful and, at times, more consistent in execution.[18–24] Certain efforts, like patient navigation and education programs, allow culturally sensitive, tailored, and patient-centric approaches; however, they are resource-intensive and can be difficult to scale.[25]

Automated patient outreach (APO) systems are a component of system-focused strategies that deliver reminders to patients outside health care encounters. Outreaches are typically performed using modalities like emails, phone calls (PCs), SMS text messages, and PP messages. APOs can be instantly transmitted and customized at a low cost. APO systems allow scalable intervention; this, in turn, permits outreach outside of the clinical encounter that fosters shared accountability between patients and their health care team.[26] Prior APO evaluations have shown improvements across a variety of patient health services, including patient lipid screening, mammogram screening, colon cancer screening, influenza vaccination, and attendance at health care appointments, and show some improvements in select chronic disease outcomes. [18,26–37]

Despite promising evidence, most APO solutions remain siloed —lacking direct integration with the electronic health record (EHR), prohibiting closed-loop feedback on outreach successes.[38–42] Therefore, health care systems may struggle to implement iterative messaging strategies and determine APO success rate(s). These limitations severely hinder the scalability, optimization, and evaluation of APOs. Emerging EHR-embedded platforms address many of these gaps by linking patient identification, communication delivery, and care completion tracking within a single framework. However, little real-world evidence exists to evaluate the effectiveness of such integrated systems. This study explores the success of a multimodal, closed-loop EHR-embedded APO system for health care services. In doing so, the study further evaluates successes by targeting outstanding service and outreach characteristics that may contribute to APO successes (e.g., SMS vs. phone vs. PP outreaches).

Objectives

The objectives of this study are to evaluate an EHR-embedded APO system and the effects of outreach and patient factors on campaign success across various recommended health care services.

Methods

Our academic safety-net health care system, the MetroHealth system in northeast Ohio, transitioned our population health outreach efforts to the use of an EHR-embedded APO. Toward this end, we conducted a retrospective observational study of the APO success of our EHR-embedded APO (Epic Cheers Campaigns). This evaluation reflects the health systems' initial implementation using definitions that were prespecified for operational population health needs. For the study purposes, APO for a specific type of outstanding health care service was defined as a "campaign." Seven different campaigns were created for the following health care services: Pediatric Lead Screening, Outstanding Labs, Immunizations, Fecal Immunochemical Testing (FIT), Stool DNA Testing, Outstanding CTs, and Outstanding Ultrasounds. This study was reviewed and defined as non-human subjects research by the MetroHealth Institutional Review Board, as no line-level protected health information (PHI) was analyzed (IRB study number: 00000798).

Campaign Creation

APO campaigns were created in Epic Cheers Campaigns, a fully integrated, multimodal patient outreach platform embedded within the Epic Systems EHR.[43] Population health operational leadership defined campaign populations, outreach frequency, and outreach content (i.e., messaging) to remind patients of outstanding health care services. APO strategies were developed with consideration of existing population health system resources, processes, and quality improvement projects. Inclusion for each campaign was defined using available EHR data (see **Table 1** for more specific inclusion criteria and timing of each campaign. See **Supplementary Appendix A** [available in the online version only] for specific content of each campaign). A single patient could qualify for multiple campaigns during the study period.

In the health care system, FIT testing is the first line for colorectal cancer screening for average-risk patients. Stool DNA testing, Cologuard, is a second-line test, primarily ordered in bulk for patients who have not completed FIT. While providers have the option to order stool DNA testing individually, bulk ordering was the primary workflow. The health care system also has dedicated phone lines and patient-facing websites regarding lead or colon cancer screening.

APO modalities included automated SMS texting (SMS), automated PP message, and automated PC. Patients were contacted based on their communication preferences recorded in the EHR (e.g., a patient who preferred SMS updates received APO via SMS). If a patient marked both SMS and PP as preferred communication methods, individual campaigns prioritized SMS or PP according to operational preferences. PC was used for patients who marked PC as their only preference or did not have an active PP or SMS-enabled phone number. Each campaign was limited to three outreach attempts ("phases"), each using the same message mode of communication (SMS, PP, or PC), per patient during the study period. Stool DNA testing was unique and had only one phase by design. See **Fig. 1** for a representation of outreach and evaluation design. If a campaign is completed or considered in process (e.g., laboratory specimen received or ultrasound appointment scheduled) after the first or second phase, no further outreach occurred. Patients had the option to opt out of individual campaigns after receiving the first message.

Outcome Evaluation(s)

Campaigns were evaluated from September 17, 2024, to April 25, 2025. Analysis was conducted on completed campaign runs that initiated during the first 3 months of each campaign. Success was defined by completion of the outstanding health care service (e.g., completion of an outstanding FIT). Data were obtained as pooled population-level data via Epic SlicerDicer,[44] a cohort query tool in the EHR. Campaign success data were extracted at the patient level via "Campaign Leads" and outreach attempt level via "Campaign Outreaches" SlicerDicer data models.

Analysis

Differences in success by outreach factors (modality and outreach phase) and patient factors (sex and age) were

Table 1 List of all automated patient outreach campaigns, their inclusion criteria, and their outreach phases

Campaign	Inclusion criteria	Outreach phase 1	Outreach phase 2	Outreach phase 3
Pediatric Lead Screening	Pediatric patients at 69, 82, or 95 weeks of age with Medicaid insurance, without previous lead screening, and living in a high-risk zip code	Day 1	Day 92	Day 183
Outstanding Labs	Adult patients who had bloodwork ordered 7, 14, or 21 days ago but not yet collected. Excluding any future or standing bloodwork orders	Day 1	Day 8	Day 15
Immunizations	Adult patients due[a] for Hepatitis A, Hepatitis B, HPV, Meningitis ACWY, DTaP, Tdap, Shingles, and pneumococcal vaccination 14, 30, or 60 days ago	Day 1	Day 16	Day 46
Stool DNA Testing	Adult patients over 45 years old who had a Stool DNA test ordered 60 days ago but not yet collected. Stool DNA testing can be bulk ordered by Population Health or individually ordered by a provider	Day 1	–	–
Fecal Immunochemical Testing (FIT)	Adult patients who had an FIT test ordered 14, 28, or 60 days ago but not yet collected. FIT test can be bulk ordered by Population Health or individually ordered by a provider	Day 1	Day 15	Day 47
Overdue CTs	An adult or pediatric patient who had a CT scan ordered in the last 10 to 16 days that has not been scheduled or completed	Day 1	Day 29	Day 71
Overdue Ultrasounds	An adult or pediatric patient who had an ultrasound ordered in the last 10 to 16 days that has not been scheduled or completed.	Day 1	Day 29	Day 71

Abbreviations: DTap, Diphtheria, Tetanus, Pertussis) Vaccine; HPV, human papillomavirus; Tdap, Tetanus, Diphtheria, Pertussis vaccine.
[a]Considered due based on system-defined care gaps using age and risk factors.

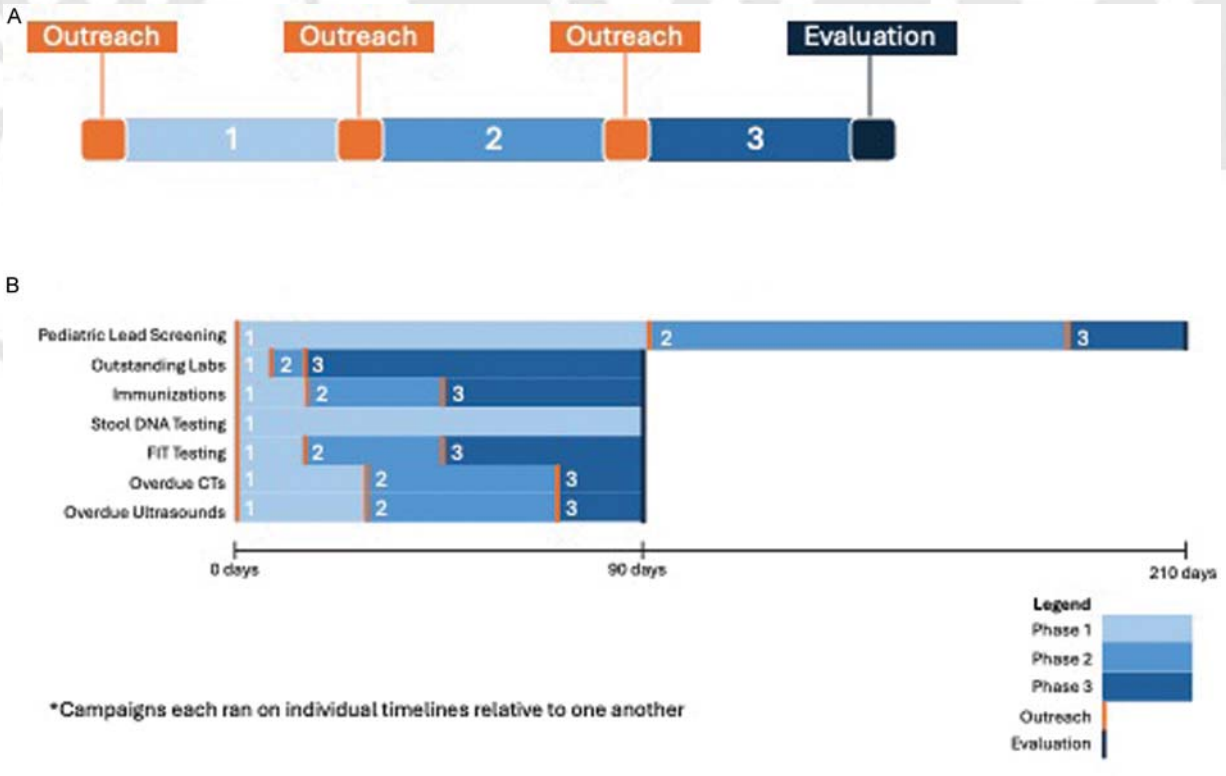

Fig. 1 (**A**) Visual representation of typical automated patient outreach cadence and evaluation. (**B**) Visual representation of individual campaigns.*

calculated using chi-square tests with individual pairwise comparisons. A Bonferroni correction was applied for multiple comparisons. Comparisons were performed for all campaigns and individually for each campaign. Significance was defined at $p < 0.05$.

Results

About 46,261 outreaches were sent to 19,537 patients across seven campaigns. Patient demographics are listed in **Table 2**. A total of 10,814 outreaches were successful, representing 23.4% of outreaches and 55.4% of patients contacted.

Table 2 Demographics of patients included in each campaign

		Lead	Labs	Imm	Colo	FIT	CT	US	Total
Age, y (%)	<18	394 (100)	0	0	0	0	10 (0.7)	85 (7.3)	489
	18–44	0	2,880 (34.8)	1,121 (30.0)	0	20 (0.5)	139 (10.3)	379 (32.5)	4,539
	45–64	0	2,907 (35.2)	1,918 (51.3)	583 (72.5)	2,677 (70.0)	622 (46.2)	363 (31.1)	9,070
	65+	0	2,477 (30.0)	697 (18.7)	221 (27.5)	1,129 (29.5)	576 (42.8)	339 (29.1)	5,439
Legal sex (%)	Male	226 (57.3)	2,863 (34.6)	1,416 (37.9)	340 (42.3)	1,523 (39.8)	591 (43.9)	399 (34.2)	7,358
Patient portal (%)	Activated	305 (77.4)	7,293 (88.3)	3,308 (88.5)	687 (85.4)	3,343 (87.4)	1,173 (87.1)	1,004 (86.1)	17,113
Total		394	8,264	3,736	804	3,826	1,347	1,166	19,537

Abbreviations: CT, computed tomography; FIT, Fecal Immunochemical Testing; US, ultrasound.

Table 3 Campaign success by outreach modality and phase

Campaign		Modality			Phase			Total
		SMS	PP	Phone	1	2	3	
Total	Outreach	27,611	16,581	2,069	19,305	14,681	12,275	46,261
	Success, % (number)	24.6 (6,805)	21.6 (3,587)	20.4 (422)	13.4 (2,596)	13.8 (2,023)	50.5 (6,195)	23.4 (10,814)
Pediatric Lead Screening (D 1, 92, 183)[a]	Outreach	300	278	85	371	206	86	663
	Success, % (number)	32.3 (97)	21.6 (60)	21.2 (18)	30.2 (112)	26.2 (54)	10.5 (9)	26.4 (175)
Outstanding Labs (D 1, 8, 15)[a]	Outreach	17,249	2,468	952	8,152	6,817	5700	20,669
	Success, % (number)	35.4 (6,107)	34.6 (853)	32.8 (312)	16.4 (1,340)	16.4 (1,119)	84.4 (4,813)	35.2 (7,272)
Immunizations (D 1, 16, 46)[a]	Outreach	8,462	1,152	522	3,688	3,439	3,009	10,136
	Success, % (number)	3.4 (289)	2.4 (28)	1.9 (10)	2.8 (104)	4.6 (158)	2.2 (65)	3.2 (327)
Stool DNA Testing (D1)	Outreach	93	677	34	804	0	0	804
	Success, % (number)	7.7 (7)	9.3 (63)	2.9 (1)	8.8 (71)	0	0	8.8 (71)
FIT Testing (D 1, 15, 47)[a]	Outreach	840	6,697	331	3,781	2,517	1,570	7,868
	Success, % (number)	14.3 (120)	18.0 (1,204)	11.8 (39)	16.3 (616)	22.4 (565)	11.6 (182)	17.3 (1,363)
Overdue CTs (D 1, 29, 71)[a]	Outreach	329	2,955	77	1,346	951	1,064	3,361
	Success, % (number)	23.7 (78)	22.4 (661)	23.4 (18)	11.7 (157)	4.8 (46)	52.1 (554)	22.5 (757)
Overdue Ultrasounds (D 1, 27, 71)[a]	Outreach	338	2,354	68	1,163	751	846	2,760
	Success, % (number)	31.7 (107)	30.5 (718)	35.3 (24)	16.9 (196)	10.8 (81)	670.6 (572)	30.8 (849)

Abbreviations: CT, computed tomography; FIT, Fecal Immunochemical Testing; PP, patient portal.
[a]Indicates days that the campaigns for the different phases of messaging occurred.

When evaluating overall campaign success by outreach modality, 24.6% (6,805) of SMS, 21.6% (3,587) of PP, and 20.4% (422) of PC outreaches were successful (**Tables 3** and **4**). SMS outreach was more likely to result in a success compared with PP (odds ratio [OR] = 1.18 [1.13–1.24], $p < 0.001$) or PC (OR = 1.28 [1.14–1.42], $p < 0.001$) outreach.

Campaigns differed in success by outreach phase. About 13.4% (2,596) of phase 1, 13.8% (2,023) of phase 2, and 50.5% (6,195) of phase 3 outreaches were successful (**Tables 3** and **4**). Phases 1 (OR = 0.15 [0.14–0.16], $p < 0.001$) and 2 (OR = 0.16 [0.14–0.16], $p < 0.001$) were less successful than phase 3.

When evaluating differences in campaign success by patient factors (**Tables 5** and **6**), male and female patients exhibited a small but statistically significant difference in success (54.2 vs. 56.0%, OR = 0.93 [0.87–0.98], $p = 0.016$). Age was strongly associated with outreach success ($p < 0.001$).

Differences by Campaign

We further evaluated success by individual campaign. Phase and modality differences at the outreach level were explored through pairwise comparisons. The overall effect of modality on success was not seen in individual campaigns. Like the effect seen across campaigns, phases 1 and 2 were significantly less successful than phase 3 for Outstanding Labs, Outstanding CTs, and Outstanding Ultrasounds campaigns. Notably, phase 2 was significantly more successful than phase 1 and 3 for Immunization (OR = 0.60 [0.46; 0.78] and OR = 2.19 [1.61; 2.96], $p < 0.001$) and FIT (OR = 0.67 [0.59; 076] and OR = 2.21 [1.83; 2.65], $p < 0.001$).

Sex and age differences at the patient level were explored through pairwise comparisons. Findings varied across individual campaigns such that males were more likely to complete Outstanding Labs (OR = 1.43 [1.23; 1.66], $p < 0.001$), whereas females were more likely to complete Outstanding CTs (OR = 0.59

Table 4 Statistical comparison for campaign success by outreach modality and phase

Campaign	Comparison	χ^2	df	*p*-Value[a]	OR	95% CI
Total	SMS vs. PP vs. Phone	63.23	2	<0.001	–	–
	SMS vs. PP	52.28	1	<0.001	1.18	1.13–1.24
	SMS vs. Phone	18.87	1	<0.001	1.28	1.14–1.42
	PP vs. Phone	1.67	1	0.590	1.08	0.96–1.20
	Phase 1 vs. 2 vs. 3	6,847.42	2	<0.001	–	–
	Phase 1 vs. 2	0.78	1	1.000	0.97	0.91–1.03
	Phase 1 vs. 3	5,119.64	1	<0.001	0.15	0.14–0.16
	Phase 2 vs. 3	4,246.28	1	<0.001	0.16	0.14–0.16
Pediatric lead screening	SMS vs. PP	8.43	1	0.011	1.74	1.17–2.57
	SMS vs. Phone	3.94	1	0.142	1.78	0.97–3.35
	PP vs. Phone	0.01	1	1.000	1.02	0.55–1.97
	Phase 1 vs. 2	1.02	1	0.937	1.22	0.81–1.82
	Phase 1 vs. 3	13.95	1	<0.001	3.70	1.76–8.67
	Phase 2 vs. 3	8.89	1	1.000	3.04	1.38–7.35
Outstanding labs	SMS vs. PP	0.67	1	1.000	1.04	0.94–1.13
	SMS vs. Phone	2.74	1	0.294	1.12	0.97–1.29
	PP vs. Phone	0.98	1	0.967	1.08	0.92–1.27
	Phase 1 vs. 2	0	1	1.000	1.00	0.91–1.09
	Phase 1 vs. 3	6,282.89	1	<0.001	0.04	0.03–0.04
	Phase 2 vs. 3	5,761.46	1	<0.001	0.04	0.03–0.04
Immunizations	SMS vs. PP	3.08	1	0.237	1.42	0.95–2.18
	SMS vs. Phone	3.44	1	0.191	1.81	0.96–3.83
	PP vs. Phone	0.43	1	1.000	1.28	0.59–2.96
	Phase 1 vs. 2	15.82	1	1.000	0.60	0.46–0.78
	Phase 1 vs. 3	2.93	1	0.260	1.31	0.95–1.82
	Phase 2 vs. 3	28.48	1	<0.001	2.18	1.61–2.96
Stool DNA testing	SMS vs. PP	0.31	1	1.000	0.79	0.29–1.80
	SMS vs. Phone	0.89	1	1.000	2.69	0.32–124.65
	PP vs. Phone	1.6	1	0.617	3.39	0 0.54–139.87
Fecal immunochemical testing	SMS vs. PP	7.03	1	0.024	0.76	0 0.61–0.93
	SMS vs. Phone	1.27	1	0.781	1.25	0.83–1.88
	PP vs. Phone	8.32	1	0.012	1.64	1.16–2.36
	Phase 1 vs. 2	37.58	1	<0.001	0.67	0.59–0.76
	Phase 1 vs. 3	19.31	1	<0.001	1.48	1.23–1.77
	Phase 2 vs. 3	76.27	1	<0.001	2.21	1.83–2.65
Overdue CTs	SMS vs. PP	0.3	1	0.5811	1.08	0.81–1.41
	SMS vs. Phone	0	1	0.9508	1.02	0.55–1.94
	PP vs. Phone	0.04	1	0.8341	0.94	0.54–1.71
	Phase 1 vs. 2	32.24	1	<0.001	2.60	1.83–3.73
	Phase 1 vs. 3	466.42	1	<0.001	0.12	0.09–0.14
	Phase 2 vs. 3	535.72	1	<0.001	0.05	0.03–0.06
Overdue ultrasounds	SMS vs. PP	0.19	1	0.6665	1.06	0.81–1.35
	SMS vs. Phone	0.34	1	0.5583	0.85	0.47–1.54
	PP vs. Phone	0.71	1	0.398	0.80	0.47–1.39
	Phase 1 vs. 2	13.57	1	0.0002	1.68	1.26–2.24
	Phase 1 vs. 3	534.35	1	<0.001	0.10	0.07–0.12
	Phase 2 vs. 3	531.54	1	<0.001	0.06	0.04–0.07

Abbreviations: CI, confidence interval; CT, computed tomography; OR, odds ratio; PP, patient portal.
[a]Adjusted χ^2 *p*-values with Bonferroni correction for multiple comparisons.

Table 5 Campaign success by patient sex and age

Campaign		Sex		Age (years)				Total
		Female	Male	<18	≥18 and <45	≥45 and <65	≥65	
Total	Patients	12,178	7,358	489	4,539	9,070	5,439	19,537
	Success, % (number)	56.0 (6,822)	54.2 (3,991)	50.1 (243)	65.5 (1,568)	46.7 (4,835)	61.8 (2,076)	55.4 (8,722)
Pediatric lead screening (D 1, 92, 183)[a]	Patients	168	226	394	0	0	0	394
	Success, % (number)	47.0 (79)	42.5 (96)	44.4 (218)	0	0	0	44.4 (218)
Outstanding labs (D 1, 8, 15)[a]	Patients	5,400	2,863	0	2,880	2,907	2,477	8,264
	Success, % (number)	86.7 (4,684)	90.4 (2,587)	0	87.2 (369)	88.5 (334)	88.3 (289)	88.0 (992)
Immunizations (D 1, 16, 46)[a]	Patients	2,320	1,416	0	1,121	1,918	697	3,736
	Success, % (number)	8.6 (200)	9.0 (127)	0	6.5 (1,048)	7.7 (1,771)	15.4 (590)	8.8 (3,409)
Stool DNA testing (D1)	Patients	464	340	0	0	583	221	804
	Success, % (number)	8.6 (40)	9.1 (31)	0	0	9.8 (526)	6.3 (207)	8.8 (733)
FIT testing (D 1, 15, 47)[a]	Patients	2,303	1,523	0	20	2,677	1,129	3,826
	Success, % (number)	36.1 (831)	34.9 (532)	0	35.0 (13)	32.0 (1,821)	44.3 (629)	35.6 (2,463)
Overdue CTs (D 1, 29, 71)[a]	Patients	756	591	10	139	622	576	1,347
	Success, % (number)	56.0 (423)	56.5 (334)	70.0 (3)	64.0 (50)	56.9 (268)	53.3 (269)	56.2 (590)
Overdue ultrasounds (D 1, 27, 71)[a]	Patients	767	399	85	379	363	339	1,166
	Success, % (number)	73.7 (565)	71.2 (284)	74.1 (22)	76.8 (88)	68.3 (115)	72.9 (92)	72.8 (317)

Abbreviation: FIT, Fecal Immunochemical Testing.
[a]Adjusted X^2 *p*-values with Bonferroni correction for multiple comparisons.

Table 6 Statistical comparison for campaign success by patient sex and age

Campaign	Comparison	χ^2	df	*p*-Value[a]	OR	95% CI
Total	Male vs. female	5.82	1	0.016	0.93	0.87–0.98
	Age	6,847.42	3	<0.001	–	–
Pediatric lead screening	Male vs. female	0.74	1	1.000	0.84	1.06–2.34
Outstanding labs	Male vs. female	23.2	1	<0.001	1.43	1.23–1.66
Immunizations	Male vs. female	0.13	1	1.000	1.04	0.82–1.32
Stool DNA testing	Male vs. female	0.06	1	1.000	1.06	0.62–1.78
FIT testing	Male vs. female	0.53	1	1.000	0.95	0.82–1.09
Overdue CTs	Male vs. female	52.48	1	<0.001	0.59	0.51–0.68
Overdue ultrasounds	Male vs. female	0.82	1	1.000	0.88	0.66–1.16

Abbreviations: CI, confidence interval; CT, computed tomography; FIT, Fecal Immunochemical Testing; OR, odds ratio; PP, patient portal.

[051; 068], $p < 0.001$) in response to an APO. Overall, findings reveal an inconsistent effect of sex. Because age eligibility varied significantly across campaigns, age comparisons at the campaign level are reported separately in **Supplementary Appendix B** (available in the online version only).

Discussion

Electronic Health Record-Embedded Automated Patient Outreach Effectively Influences Health Behavior

EHR-embedded APOs offer an effective means to encourage completion of outstanding health care services. In total, 23.4% of outreach attempts were successful, and 55.4% of patients contacted completed an outstanding service. Findings of this evaluation are, thereby, poised to contribute both to the literature on systems-based approaches for APO and guide health care systems on how to appropriately engage patients to uptake outstanding health care services through APO approaches.

Overall success varied by campaign. Immunizations and Stool DNA Testing showed the lowest success rates, while Outstanding Labs had the highest. Meanwhile, Pediatric Lead Screening outreaches were directed toward parent(s)/guardian(s) as proxies for pediatric patients, while the remainder of the campaigns were sent directly to the patient. Proxies may be more motivated to act on behalf of dependents than patients contacted directly.[45,46]

Low immunization campaign success rates may reflect growing vaccine hesitancy, for which APOs may not be the appropriate

intervention.[47,48] Similarly, at the institution, Stool DNA testing is reserved for patients who did not complete FIT testing or colonoscopies for colorectal cancer screening. The baseline population likely reflects a population unwilling or unable to complete screening. Additional evaluation is required to understand what factors affect APO success, and thus when to utilize APOs.

SMS Outreach is Most Effective

Automated SMS outreach was associated with the highest success, outperforming automated PP and PC messages. SMS outreach is often preferable to PP,[26] but the literature surrounding the effectiveness of PC versus SMS reminders[49–51] is mixed. Our results suggest that automated PCs are less effective than SMS reminders in this patient population. Importantly, the effect of modality on overall campaign data was not replicated within individual campaigns. Patient characteristics may contribute to heterogeneity of results; however, the analyses relied on pooled population data, prohibiting us from testing patient and campaign factor interaction effects.

PP may be less successful as preventative care gaps and outstanding orders are typically already highlighted in the PP. Patients who have not acted based on PP content may respond to nudges via a different modality. Lower success may also be related to less consistent internet access or digital literacy, commonly described as the "digital divide."[52–54] Also, PP messages require login for full content review; prior to logging in, they only receive a tickler message (SMS or email) to check the PP without specifying details, whereas SMS and PC message details are immediately visible. PCs may be limited by reluctance to pick up unexpected or unknown PCs, although our PCs were branded with the health care system name for phones that show caller ID. Additionally, PC content is not easily revisited like a PP or SMS message.

Effective Outreach Requires Multiple Attempts Based on Service Type

Success varied by the number of outreach attempts, with the third outreach of our three outreaches most strongly associated with completion of the outstanding health care service. Campaign-specific analysis demonstrates that either the second or third outreach was most successful, consistent with prior literature demonstrating the effectiveness of repeated reminders.[55]

Heterogeneity between the number of attempts associated with completion may be related to the logistics of completing the desired health care service. Health care services with fewer logistical barriers and longer time window periods for completion between reminders/measurements (i.e., FIT and Immunizations) were more successful after the second outreach. Services like CT, Ultrasound, and Laboratory, which may require preparation (e.g., fasting), prior authorization, and scheduled appointments, and had shorter time window periods for completion between reminders/measurements, were more successful after the third outreach. At our institution, FIT tests are completed at home and mailed in via pre-posted envelopes, and immunizations can also be completed as a walk-in at health system pharmacies that are open for longer hours.

Campaigns were developed according to operational requirements, and each campaign had different phase lengths. Thereby, the timing of each outreach attempt may also play a role in this finding.

Patient Attributes May or May Not Affect Automated Patient Outreach Success

Overall, male and female patients had a small but statistically significant difference in success. However, this finding was not consistently replicated within individual campaigns. Given the mix of our findings and literature on men being less likely to engage in preventative care,[56,57] this is an area worthy of further investigation. APOs may be one way to reduce differences in utilization of health care services.

Prior literature has raised concerns about an "age-based digital divide" where older people may be more hesitant and unlikely to engage with digital health platforms, including PP.[58,59] Age was strongly associated with outreach success across campaigns. Additional study is necessary to understand the interaction between age and outreach characteristics on different types of APOs.

Implications

Our findings underscore the importance of understanding patient characteristics when designing outreach, highlighting that APOs should be tailored to the populations they serve. APOs should be considered a component of system-level population health interventions and can be used alongside other tools such as provider-facing EHR notifications, patient navigation, and community resource development. EHR-embedded APOs enable closed-loop efficient reporting on outreach outcomes, and thus rapid-cycle adjustments of messaging content, frequency, and modality. EHR-embedded APOs may also be more cost-effective as opposed to other third-party APOs and may also be less resource-intensive to implement, not needing separate patient identification, messaging, and reporting processes.

APO programs must be thoughtfully designed with specific attention to messaging modality, frequency, and content. While SMS outreach is the most effective, APO systems should continue utilizing PP and PC. PP remains important. SMS and PC are not HIPAA-compliant methods of communication and cannot contain PHI. In addition to being able to include PHI in the PP (i.e., may include more specific patient information), the PP also allows for direct integration with other portal functions (e.g., self-scheduling and outstanding order review), and lower costs as SMS and PC often require a small fee. PC is important because, despite high mobile phone adoption, there are still populations that prefer or only utilize landlines or cellphones without SMS.[60]

While more messages (in our study, up to three) generally seem to be more effective to drive the desired outcome, outreach strategies should be informed by program goals and patient population characteristics to balance effectiveness with the risk of over-messaging.

Risk of Over-Messaging

Each implementation of health information-related technologies should be wary of unintended consequences.[61] Not explicitly explored, but exceedingly important to consider are the unintentional consequence(s) of automated messaging and the risk of over-messaging to patients. While overall success was observed for 22.4% of outreaches and 55.4% of patients contacted, roughly four in five outreaches to one in two patients were not associated with success, illustrating alert burden for non-responders. Like provider alert fatigue, outreaches may produce "patient alert

fatigue" perceived as noise, ultimately undermining the outreach's intended goals. Previous studies have also shown that high volumes of automated health care messages may cause patients to opt out of future messages.[62,63] Patients should be active participants in the design, implementation, and evaluation of initiatives that affect them.[64] Future study should consider patient perception of automated messaging, including application of user-centered design to improve and/or generate APO programs that provide value to patients.

Strengths and Limitations

Our study has several limitations. First, it took place within a single, academically affiliated safety-net health care system. While many health care systems may utilize the same EHR vendor and consequently may have access to a similar APO system,[65] findings may not generalize to different populations and care settings. Second, the APO system is limited by the data available in the local EHR, and robust health information exchange (HIE) needs to be incorporated into the underlying EHR to account for care completed outside the health system.[66] Third, APOs targeted different outstanding health care services with varying timelines for phased outreach, introducing potential temporal confounders. Fourth, data were pooled from a large cohort of diverse patients across multiple campaigns, limiting the ability to evaluate the effect of the interaction between patient and outreach characteristics on campaign success. Finally, some successes may have occurred natively without campaign outreaches; however, these patients were already determined to be at least 7 days overdue for the desired health care service (see **Table 1**, column 2). A pre-/post-study with randomized assignment could help quantify how much of a desired health behavior is attributable to the campaign and outreach modality.

Conclusion

As 53% of PCPs report needing additional time per established care patient to comprehensively address their patient needs, including completion of outstanding cancer screenings, immunizations, laboratory work, and imaging studies, the utility of APOs in increasing desired health behaviors is promising. Barriers to completion of health care services are multifaceted,[16] and systems-focused approaches are necessary to alleviate provider burden while providing high-quality care.

EHR-embedded APOs offer distinct advantages by streamlining patient identification, communication delivery, and closed-loop care completion tracking, and can be significantly more cost-effective. Automated, multimodal patient outreach using EHR-embedded APOs are an effective means to encourage completion of outstanding health care services. SMS was most successful compared with PP and PC outreach, and the desired patient outcome increases with more messages and over time. Patient characteristics like age and sex are associated with APO performance. Future work should include the patient perspective in campaign co-design, assessing patient perceptions of APOs, as well as further HIE integration to capture patient health status and minimize unnecessary outreach. Opportunities for ongoing research include understanding what patient characteristics affect communication preferences and campaign success. Future studies should explore how message characteristics like content, ability to interact, time sent, multiple message modes to the same patient, and timing between messages influence behavior. Additionally, research is necessary on how automated outreach affects clinical outcomes.

Clinical Relevance Statement

For health systems, this research shows that EHR-embedded APO can promote completion of overdue health care services by streamlining patient identification, outreach delivery, and completion tracking. These findings suggest that outreach modality and frequency play a role in driving desired patient outcomes.

Multiple-Choice Questions

1. When designing an APO strategy, what is an advantage of an EHR-embedded APO over a non-EHR-embedded APO?

   a. You can use multiple modalities and frequencies for automated outreach.
   b. Patient identification, communication delivery, and care completion tracking can be streamlined.
   c. The increased cost of software and implementation.
   d. There are no advantages of an EHR-embedded APO.

   Correct Answer: The correct answer is option b. The manuscript highlights that an EHR-embedded allow distinct advantages when streamlining patient identification, communication delivery, and care completion tracking. These advantages may be significantly cost-effective.

2. What was the observed effect of modality on the likelihood of outreach success?

   a. SMS outreach was most effective.
   b. Patient portal outreach was most effective.
   c. Phone call outreach was most effective.
   d. There was no difference between outreaches.

   Correct Answer: The correct answer is option a. The study suggests that automated SMS outreach outperformed automated PP and PC messages. Modality selection should consider local workflows and patient needs.

3. What was the observed effect of message frequency on the likelihood of outreach success?

   a. One message is most often required to drive the desired outcome.
   b. Two messages are most often required to drive the desired outcome.
   c. Three messages are most often required to drive the desired outcome.
   d. There was no difference between outreaches.

   Correct Answer: The correct answer is option c. The study suggests that the third outreach is most often associated with the desired outcome. It is important to note that over-messaging may lead to patient message fatigue; therefore, programs should consider outreach volume and coordination within an enterprise communication strategy.

Author Affiliations

1 Center for Clinical Informatics Research and Education, The MetroHealth System, Cleveland, Ohio, United States

2 Departments of Family Medicine and Community Health and Clinical Informatics Center, UT Southwestern Medical Center, Dallas, Texas, United States

3 Department of Family Medicine, The MetroHealth System and Case Western Reserve University, Cleveland, Ohio, United States

4 Department of Internal Medicine, The MetroHealth System and Case Western Reserve University, Cleveland, Ohio, United States

5 Departments of Information Services, Internal Medicine, Pediatrics, Epidemiology, and Biostatistics, Case Western Reserve University, Cleveland, Ohio, United States

6 Center for Health Care Research and Policy, The MetroHealth System, Cleveland, Ohio, United States

Statements and Additional Information

Conflict of Interest The authors declare that they have no conflict of interest.

Contributors' Statement K.L.L.: conceptualization, data curation, formal analysis, investigation, methodology, project administration, writing–original draft. E.J.: data curation, formal analysis, writing–original draft. Y.T.: formal analysis, writing–review and editing. D.C.K.: conceptualization, formal analysis, project administration, writing–review and editing. A.R-C.: formal analysis, writing–review and editing. A.H.: conceptualization, data curation, formal analysis, investigation, methodology, project administration, writing–review and editing.

Acknowledgement The authors would like to acknowledge Nisrine Khazaal, Tammy Robinson, Mark Perez, and Bridget Perea for their key role in designing and implementing Epic Cheers Campaign, our automated patient outreach software.

Protection of Human and Animal Subjects This study was reviewed and defined as non-human subjects research by the MetroHealth Institutional Review Board. No animal subjects were involved in this research.

Supplementary Material is available at https://doi.org/10.1055/a-2900-1614

References

1 Watson KB, Wiltz JL, Nhim K, Kaufmann RB, Thomas CW, Greenlund KJ. Trends in multiple chronic conditions among US adults, by life stage, behavioral risk factor surveillance system, 2013-2023. Prev Chronic Dis 2025;22:E15

2 Porter J, Boyd C, Skandari MR, Laiteerapong N. Revisiting the time needed to provide adult primary care. J Gen Intern Med 2023;38(01):147–155

3 Nguyen MT, Honcharov V, Ballard D, Satterwhite S, McDermott AM, Sarkar U. Primary care physicians' experiences with and adaptations to time constraints. JAMA Netw Open 2024;7(04):e248827

4 Prasad K, Poplau S, Brown R, et al; Healthy Work Place (HWP) Investigators Time pressure during primary care office visits: a prospective evaluation of data from the healthy work place study. J Gen Intern Med 2020;35(02):465–472

5 Bodenheimer T, Pham HH. Primary care: current problems and proposed solutions. Health Aff (Millwood) 2010;29(05):799–805

6 Hoffman S, Ganguli I. Access to Primary Care and Health Care Fragmentation. Faculty Publications. January 1, 2026. Accessed June 23, 2026 at: https://scholarlycommons.law.case.edu/faculty_publications/2327

7 HRSA Health Workforce. State of the Primary Care Workforce. 2024. Accessed June 23, 2026 at: https://bhw.hrsa.gov/sites/default/files/bureau-health-workforce/data-research/State-of-the-Primary-Care-Workforce-2025.pdf

8 Hoffer EP. Primary care in the United States: past, present and future. Am J Med 2024;137(08):702–705

9 Lacson R, Healey MJ, Cochon LR, et al. Unscheduled radiologic examination orders in the electronic health record: a novel resource for targeting ambulatory diagnostic errors in radiology. J Am Coll Radiol 2020;17(06):765–772

10 Fischer SH, Field TS, Gagne SJ, et al. Patient completion of laboratory tests to monitor medication therapy: a mixed-methods study. J Gen Intern Med 2013;28 (04):513–521

11 Gagne S, Fischer S, Preusse P, Mazor K, Tjia J, Field T. PS2–13: why patients fail to complete laboratory monitoring requests? Clin Med Res 2011;9(3–4):158–159

12 Ma ZQ, Richardson LC. Cancer screening prevalence and associated factors among US adults. Prev Chronic Dis 2022;19:E22

13 Crosby D, Bhatia S, Brindle KM, et al. Early detection of cancer. Science 2022;375 (6586):eaay9040

14 Chen AM. Barriers to health equity in the United States of America: can they be overcome? Int J Equity Health 2025;24(01):39

15 Borsky A, Zhan C, Miller T, Ngo-Metzger Q, Bierman AS, Meyers D. Few Americans receive all high-priority, appropriate clinical preventive services. Health Aff (Millwood) 2018;37(06):925–928

16 Allen EM, Call KT, Beebe TJ, McAlpine DD, Johnson PJ. Barriers to care and health care utilization among the publicly insured. Med Care 2017;55(03):207–214

17 Bergeson SC, Dean JD. A systems approach to patient-centered care. JAMA 2006;296(23):2848–2851

18 Finney Rutten LJ, Griffin JM, St Sauver JL, et al. Multilevel implementation strategies for adolescent human papillomavirus vaccine uptake: a cluster randomized clinical trial. JAMA Pediatr 2024;178(01):29–36

19 Rodriguez AL, Cappelletti L, Kurian SM, Passio C, Rux S. Transitional care navigation. Semin Oncol Nurs 2024;40(02):151580

20 Waddell KJ, Goel K, Park SH, et al. Association of electronic self-scheduling and screening mammogram completion. Am J Prev Med 2024;66(03):399–407

21 Atlas SJ, Tosteson ANA, Wright A, et al. A multilevel primary care intervention to improve follow-up of overdue abnormal cancer screening test results: a cluster randomized clinical trial. JAMA 2023;330(14):1348–1358

22 Lukanski A, Watters S, Bilderback AL, et al. Implementing a discharge follow-up phone call program reduces readmission rates in an integrated health system. J Healthc Qual 2023;45(06):315–323

23 Lacson R, Gujrathi I, Healey M, et al. Closing the loop on unscheduled diagnostic imaging orders: a systems-based approach. J Am Coll Radiol 2021;18(1 Pt A):60–67

24 Nelson HD, Cantor AG, Pappas M, Blackie K, Yu Y, Fu R. Patient navigation services for breast and cervical cancer screening and follow-up: a meta-analysis. JAMA Intern Med 2025;185(08):976–985

25 Dietrich AJ, Tobin JN, Cassells A, et al. Telephone care management to improve cancer screening among low-income women: a randomized, controlled trial. Ann Intern Med 2006;144(08):563–571

26 Perri-Moore S, Kapsandoy S, Doyon K, et al. Automated alerts and reminders targeting patients: a review of the literature. Patient Educ Couns 2016;99 (06):953–959

27 Mehta SJ, Rhodes C, Linn KA, et al. Behavioral interventions to improve breast cancer screening outreach: two randomized clinical trials. JAMA Intern Med 2024;184(07):761–768

28 Derose SF, Green K, Marrett E, et al. Automated outreach to increase primary adherence to cholesterol-lowering medications. JAMA Intern Med 2013;173 (01):38–43

29 Pollak C, Parambath A, Coratti S, et al. Default bulk ordering and text messaging to enhance outreach for lipid screening: a randomized clinical trial. JAMA Cardiol 2025;10(04):313–320

30 Macharia WM, Leon G, Rowe BH, Stephenson BJ, Haynes RB. An overview of interventions to improve compliance with appointment keeping for medical services. JAMA 1992;267(13):1813–1817

31 Gagliardi KS, Coleman S, Intinarelli G, et al. An automated telephone call system improves the reach and cost-effectiveness of panel management outreach for cancer screening. J Ambul Care Manage 2020;43(02):148–156

32 Berset AE, Burkhardt MC, Xu Y, Mescher A, Brinkman WB. Effect of automated and personalized outreach messages on well-child visit catch up: a randomized clinical trial. Acad Pediatr 2024;24(06):914–921

33 Szilagyi PG, Albertin C, Casillas A, et al. Effect of patient portal reminders sent by a health care system on influenza vaccination rates: a randomized clinical trial. JAMA Intern Med 2020;180(07):962–970

34 Wynter J, Hurwitz S, Saltzman JR, Nayor J. Automated time-released reminders improve patient access to colonoscopy. Gastroenterol Nurs 2021;44(02):129–135

35 Gurol-Urganci I, de Jongh T, Vodopivec-Jamsek V, Atun R, Car J. Mobile phone messaging reminders for attendance at healthcare appointments. Cochrane Database Syst Rev 2013;2013(12):CD007458

36 Lesser LI, Datta E, Behal R. Electronically-delivered push notifications improve patient adherence to preventive care. J Am Board Fam Med 2025;38(02):239–246

37 Chacko J, Mazza K, Stathakos K, Kim D, Carlo L. Evaluating technology-driven strategies for enhancing patient outreach for preventive care: a systematic review. Cureus 2025;17(02):e79467

38 Gessner D, Hunter OO, Kou A, Mariano ER. Automated text messaging follow-up for patients who receive peripheral nerve blocks. Reg Anesth Pain Med 2021;46 (06):524–528

39 Kempe A, Stockwell MS, Szilagyi P. The contribution of reminder-recall to vaccine delivery efforts: a narrative review. Acad Pediatr 2021;21(4S):S17–S23

40 Reisman M. EHRs: The challenge of making electronic data usable and interoperable. P T 2017;42:572–575

41 Walker DM, Tarver WL, Jonnalagadda P, Ranbom L, Ford EW, Rahurkar S. Perspectives on challenges and opportunities for interoperability: Findings from key informant interviews with stakeholders in Ohio. JMIR Med Inform 2023;11(01):e43848

42 Kruse CS, Stein A, Thomas H, Kaur H. The use of electronic health records to support population health: a systematic review of the literature. J Med Syst 2018;42(11):214

43 Epic. Cheers: The CRM for Healthcare. Accessed September 29, 2025 at: https://www.epic.com/software/cheers/

44 Epic. Healthcare Intelligence. Accessed September 29, 2025 at: https://www.epic.com/software/healthcare-intelligence/

45 McManus KE, Bertrand A, Snelling AM, Cotter EW. In their own words: parents and key informants' views on nutrition education and family health behaviors. Int J Environ Res Public Health 2021;18(15):8155

46 Jarvis MJ. The association between having children, family size and smoking cessation in adults. Addiction 1996;91(03):427–434

47 Mehta SJ, Mallozzi C, Shaw PA, et al. Effect of text messaging and behavioral interventions on COVID-19 vaccination uptake: a randomized clinical trial. JAMA Netw Open 2022;5(06):e2216649

48 Burkhardt MC, Berset AE, Xu Y, Mescher A, Brinkman WB. Effect of outreach messages on adolescent well-child visits and coronavirus disease 2019 vaccine rates: a randomized, controlled trial. J Pediatr 2023;253:158–164.e1

49 Chen ZW, Fang LZ, Chen LY, Dai HL. Comparison of an SMS text messaging and phone reminder to improve attendance at a health promotion center: a randomized controlled trial. J Zhejiang Univ Sci B 2008;9(01):34–38

50 Junod Perron N, Dao MD, Righini NC, et al. Text-messaging versus telephone reminders to reduce missed appointments in an academic primary care clinic: a randomized controlled trial. BMC Health Serv Res 2013;13:125

51 Alturbag M. Effectiveness of personalised phone calls and short message service reminders in improving patient attendance at a radiology department. Cureus 2024;16(09):e69568

52 Grossman LV, Masterson Creber RM, Benda NC, Wright D, Vawdrey DK, Ancker JS. Interventions to increase patient portal use in vulnerable populations: a systematic review. J Am Med Inform Assoc 2019;26(8-9):855–870

53 Anthony DL, Campos-Castillo C, Lim PS. Who isn't using patient portals and why? evidence and implications from a national sample of US adults. Health Aff (Millwood) 2018;37(12):1948–1954

54 Otokiti A, Williams KS, Warsame L. Impact of digital divide on the adoption of online patient portals for self-motivated patients. Healthc Inform Res 2020;26(03):220–228

55 Steiner JF, Shainline MR, Dahlgren JZ, Kroll A, Xu S. Optimizing number and timing of appointment reminders: a randomized trial. Am J Manag Care 2018;24(08):377–384

56 Rolnick SJ, Pawloski PA, Hedblom BD, Asche SE, Bruzek RJ. Patient characteristics associated with medication adherence. Clin Med Res 2013;11(02):54–65

57 Vaidya V, Partha G, Karmakar M. Gender differences in utilization of preventive care services in the United States. J Womens Health (Larchmt) 2012;21(02):140–145

58 Ramsetty A, Adams C. Impact of the digital divide in the age of COVID-19. J Am Med Inform Assoc 2020;27(07):1147–1148

59 Mubarak F, Suomi R. Elderly forgotten? Digital exclusion in the information age and the rising grey digital divide. Inquiry 2022;59:469580221096272

60 Chamber Of Commerce. Data Reveals Landline Phone Decline Statistics. April 16, 2024. Accessed September 29, 2025 at: https://www.chamberofcommerce.-org/landline-phone-statistics

61 Ray JM, Ratwani RM, Sinsky CA, et al. Six habits of highly successful health information technology: powerful strategies for design and implementation. J Am Med Inform Assoc 2019;26(10):1109–1114

62 So J, Kim S, Cohen H. Message fatigue: conceptual definition, operationalization, and correlates. Commun Monogr 2019;84:5–29. Accessed September 29, 2025 at: https://www.tandfonline.com/doi/full/10.1080/03637751.2016.1250429

63 Steiner JF, Zeng C, Comer AC, et al. Factors associated with opting out of automated text and telephone messages among adult members of an integrated health care system. JAMA Netw Open 2021;4(03):e213479

64 van Leeuwen D, Mittelman M, Fabian L, Lomotan EA. Nothing for me or about me, without me: codesign of clinical decision support. Appl Clin Inform 2022;13(03):641–646

65 EpicShare. Closing Preventive Care Gaps and Improving Population Health with Automated Outreach. Accessed September 29, 2025 at: https://www.epicshare.-org/share-and-learn/cheers-vaccination-care-gaps

66 Hersh W, Totten A, Eden K, et al. Health information exchange. Evid Rep Technol Assess (Full Rep) 2015;(220):1–465