CLINICAL TRIALS

Clinical Trials
2019, Vol. 16(3) 306–315

DOI: 10.1177/1740774519839062
journals.sagepub.com/home/ctj
SAGE

Establishing an electronic health record–supported approach for outreach to and recruitment of persons at high risk of type 2 diabetes in clinical trials: The vitamin D and type 2 diabetes (D2d) study experience

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Abstract

Aims: To establish recruitment approaches that leverage electronic health records in multicenter prediabetes/diabetes clinical trials and compare recruitment outcomes between electronic health record–supported and conventional recruitment methods.

Methods: Observational analysis of recruitment approaches in the vitamin D and type 2 diabetes (D2d) study, a multicenter trial in participants with prediabetes. Outcomes were adoption of electronic health record–supported recruitment approaches by sites, number of participants screened, recruitment performance (proportion screened who were randomized), and characteristics of participants from electronic health record–supported versus non–electronic health record methods.

Results: In total, 2423 participants were randomized: 1920 from electronic health record (mean age of 60 years, 41% women, 68% White) and 503 from non–electronic health record sources (mean age of 56.9 years, 58% women, 61% White). Electronic health record–supported recruitment was adopted by 21 of 22 sites. Electronic health record–supported recruitment was associated with more participants screened versus non–electronic health record methods (4969 vs 2166 participants screened), higher performance (38.6% vs 22.7%), and more randomizations (1918 vs 505). Participants recruited via electronic health record were older, included fewer women and minorities, and reported higher use of dietary supplements. Electronic health record–supported recruitment was incorporated in diverse clinical environments, engaging clinicians either at the individual or the healthcare system level.

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Conclusion: Establishing electronic health record–supported recruitment approaches across a multicenter prediabetes/diabetes trial is feasible and can be adopted by diverse clinical environments.

Keywords
Prediabetes, diabetes, recruitment, trial, health records

Introduction

Standards of care for the treatment of patients with diabetes and prediabetes relies on the wealth of evidence generated from well-conducted randomized controlled trials, which remain the gold standard in establishing efficacy and safety of therapeutic interventions.[1] However, engagement and recruitment of patients into trials remains a major challenge.[2–4] Ineffective recruitment methods and inability to meet target sample sizes lead to underpowered studies with inconclusive results,[2,3,5] compromising the objectives of clinical research to address important clinical questions and undermining the contribution of those who do participate.[4]

Traditional recruitment of patients with diabetes or prediabetes has included broad, imprecise methods, such as mass mailings, advertisements, community events, and clinician referrals. For example, in the Diabetes Prevention Program study, which enrolled 3819 participants at risk of diabetes from 1996 to 1999, the most common recruitment methods were mass mailings, advertisements, and community screenings. Although successful at meeting recruitment targets, these methods (41 people screened for 1 randomization) are inefficient by contemporary standards.[6]

Electronic health records (EHRs) were developed to facilitate access to clinical information; however, use of EHR holds the potential to transform recruitment of patients in research studies by optimizing identification of potential participants and by facilitating engagement of clinical providers in research. There is limited data on the role of EHR in the modern era of clinical trial recruitment and approaches to implementing EHR-supported recruitment across multicenter trials. We report on our methods and results of establishing EHR-supported recruitment of patients with prediabetes across a large multicenter trial, including the integration of primary care providers and other local stakeholders, and compare recruitment outcomes and characteristics of enrolled participants between EHR-supported approaches and conventional (i.e. non-EHR) methods.

Participants

Target participants were adults with prediabetes. Eligible participants had to meet at least two of three glycemic criteria for prediabetes established by the American Diabetes Association in 2010: fasting plasma glucose 100–125 mg/dL (5.5–6.9 mmol/L); 2-h plasma glucose after a 75-g glucose load 140–199 mg/dL (7.7–11.0 mmol/L); and hemoglobin A1c (HbA1c) 5.7%–6.4% (39–46 mmol/mol).[7] The main exclusion criterion was fasting plasma glucose, 2-h plasma glucose, or HbA1c in the diabetes range.[8]

Materials and methods

Overview of the D2d study

The vitamin D and type 2 diabetes (D2d) study is a US-based, multicenter, randomized, double-blind, placebo-controlled, primary prevention clinical trial comparing oral administration of 4000 IU/day of cholecalciferol (vitamin D_3) versus placebo in people with prediabetes who are followed for incident diabetes for approximately 3 years after randomization.[8] The study is approved and monitored by an independent Data and Safety Monitoring Board and the Institutional Review Board of each collaborating clinical research site. This study is an observational analysis of recruitment approaches in the D2d study.

Development of recruitment methods and data collection

The D2d Coordinating Center developed a Recruitment and Retention Manual of Procedures, which was continuously revised and shared throughout the study. Study organization ensured that multiple groups (Coordinating Center, Executive Committee, Recruitment and Retention Subcommittee) tracked recruitment and provided ongoing feedback. Recruitment results were reviewed weekly, aiming to provide real-time feedback of recruitment progress, identify areas for improvement, and disseminate best practices to the clinical sites.

Data on recruitment method for each participant were systematically collected at the time of screening. The recruitment method was defined at the individual participant level and site staff entered data into the electronic data capture system using pre-defined categories, as follows: an EHR-supported approach consisted of a systematic review of data from the local EHR to identify patients that met key eligibility criteria (e.g. age, HbA1c, and body mass index (BMI); Text Box 1).

Text Box 1. Example EHR query to identify potentially eligible participants for the vitamin D and type 2 diabetes (D2d) study.

HGBA1C (last entry) is greater than 5.9
HGBA1C (last entry) is less than 6.5
Date of Last Observation Entry is before [yesterday's date]
Date of Last Observation Entry is or after [date 90 days before yesterday's date]
Birthdate is before [maximum age bound]
Birthdate is on or after [minimum age bound]
BMI (last entry) is less than 41
BMI (last entry) is greater than 22
Problem Code, Active (Diagnosis lookup) is not DM (ICD-250.00)
Medication Code, Active (Classification lookup) is not ANTIDIABETICS
Medication Code, Active (Classification lookup) is not VITAMIN D
Medication Code, Any (Classification lookup) is not PREDNISONE
Problem Code, Active (Diagnosis lookup) is not CHRONIC KIDNEY DISEASE STAGE V (ICD-585.5)
Problem Code, Active (Diagnosis lookup) is not CHRONIC KIDNEY DISEASE STAGE IV(SEVERE) (ICD-585.4)
Problem Code, Active (Diagnosis lookup) is not HYPERCALCEMIA (ICD-275.42)

EHR: electronic health record.

Non-EHR methods consisted of participant referrals, advertisements, local research participant databases, information from "within" the health system (e.g. employee newsletters, hospital TV, and intranet), community events (e.g. health fairs and community gatherings), internet searches by patients, publicity and news stories, or other databases (e.g. marketing lists).

Overview of screening

Regardless of the method of recruitment, all potential participants underwent site-specific pre-screening, including phone pre-screening, medical chart review when available, and—at some sites—targeted laboratory testing (fasting plasma glucose and HbA1c). Potential participants who met pre-screening criteria were invited for in-person screening, which occurred in two steps. At screening visit 1, non-glycemic eligibility criteria (e.g. medical history, laboratory criteria for safety) were confirmed and glycemic criteria for prediabetes were preliminarily evaluated by measuring fasting plasma glucose and HbA1c. Algorithms utilizing the screening visit 1 glycemic results guided sites as to which participants should proceed to the next screening visit. At screening visit 2, a 75-g oral glucose tolerance test was performed after an 8-h overnight fast, and fasting plasma glucose, 2-h plasma glucose, and HbA1c were collected and analyzed by the D2d central laboratory to determine final eligibility. Screening visit 2 served as the baseline visit for participants who were randomized.

Recruitment started in October 2013 with a goal of recruiting 2382 people among 19 clinical research sites over a 2-year period. Each site was expected to contribute approximately 125 randomized participants. By the end of year 1, one site was discontinued and four sites were added for a total of 22 sites.

Assessment of recruitment approaches

Adoption of EHR-supported recruitment approaches across sites is described. A site was considered "operational" with EHR-supported recruitment when at least three participants identified via EHR completed screening visit 1 within a 30-day period. A comparison of EHR-supported approaches to non-EHR methods on recruitment outcomes was conducted. Number of participants screened refers to the number of participants who completed screening visit 1 and recruitment "performance" refers to the proportion of participants who completed screening visit 1 and were randomized. Differences in descriptive characteristics of randomized participants recruited via EHR-supported approaches versus non-EHR methods are reported. We qualitatively describe the engagement of key stakeholders required to implement EHR-supported outreach across diverse environments at the different sites in a multicenter trial (Text Box 2). Qualitative information about individual-site EHR-based recruitment approaches (e.g. whether consent of medical practice and/or individual primary care provider was required to query EHR, whether engagement of individual primary care providers was sought) was assessed by a survey distributed to the sites.

Data analyses

Rate of adoption of EHR-supported approaches, number of participants screened, recruitment performance, and total randomizations were assessed. Number of participants screened, recruitment performance, and characteristics of participants recruited from EHR-supported approaches versus non-EHR methods were compared using t-tests and chi-square tests as appropriate. Two-sided p-values less than 0.05 were considered statistically significant. SAS (Version 9.4, SAS Institute Inc., Cary, NC, USA) was used for all analyses.

Text Box 2. Key stakeholders, roles, and lessons learned during the implementation of electronic health record (EHR)-supported recruitment of clinical trial participants.

Key stakeholder	Role	Lessons learned
Coordinating Center	Take a broad, multi-site view. Disseminate targeted information and connect staff across sites based on individual site processes and challenges. Lead, encourage, and motivate sites.	Connecting experienced sites with sites with less experience was invaluable. Sharing information (e.g. query criteria) across sites enhanced efficiency overall. Coordinate, update, and disseminate resources to support recruitment efforts throughout recruitment period
Site principal investigator	Serve as a bridge between clinical and research departments; cultivate relationships with primary care providers; help develop and refine the site-specific EHR approach; work with site research staff to develop and improve communication approaches with potential participants and clinician partners.	An engaged and involved site principal investigator was critically important in bringing other stakeholders together toward the common goal of sharing the study opportunity with potentially eligible patients, especially in sites that were new to EHR-supported recruitment approaches.
Site research staff	In collaboration with site principal investigator, work with EHR liaison (see below) to develop a study-specific search strategy; perform outreach to potentially eligible patients identified by the EHR search; maintain communication with physician partners.	Most research staff were new to EHR-supported recruitment; thus, it was essential to educate staff on establishing and conducting an EHR approach tailored to the local resources and culture.
Institutional Review Board (IRB)	Review and approve EHR-supported recruitment approach.	As using EHR for study recruitment was new at many sites, it was essential to educate the local IRB on the importance and the process of sharing the study opportunity with potentially eligible patients while complying with local policies and patient privacy protection rules.
EHR/health information technology (IT) leadership and liaison	Query EHR with regular frequency for potentially eligible patients; provide results to the research staff in a user-friendly format. In some sites, the coordinator could directly query the EHR without assistance by IT.	Access to EHR is now ubiquitous; however, use of EHR for recruitment is uncommon. Site investigators had to engage and educate the EHR/IT leadership that the use of EHR to recruit participants is a key function of the academic center's research mission. Some site investigators and staff had to work closely with an EHR/IT liaison to develop a search strategy, including frequency (e.g. monthly or quarterly), and refine the search strategy based on results.
Clinician partners (for sites that engaged primary care providers)	Endorse the EHR-supported recruitment approach; provide approval to share study information with potentially eligible patients; encourage their patients to consider participation, include outreach letters signed by the primary care provider, and be supportive of study participation when asked at a clinical visit by their patients.	Identification of individual physicians willing to support EHR-supported recruitment was critical. Identification of physician champions or leaders that could educate and influence other providers in their practice was helpful. Establishing good working relationships between site investigator/staff and physicians was critical.

Results

Adoption of EHR-supported recruitment approaches across sites

Site-specific EHR-supported approaches were operational in five sites (26% of actively recruiting sites) within 3 months of the start of recruitment (Figure 1). Their experiences were shared study-wide early during recruitment, through conference calls, in-person investigator meeting activities, and email communications. A dedicated web portal served as a real-time resource and sharing center, including query terms that sites found to be effective in translating eligibility criteria to the EHR search (Text Box 1), sample letters to primary care providers and their patients, and telephone pre-screening scripts. Experience in non-EHR methods was similarly shared. An EHR-supported approach was operational in 15 sites (83%) within a

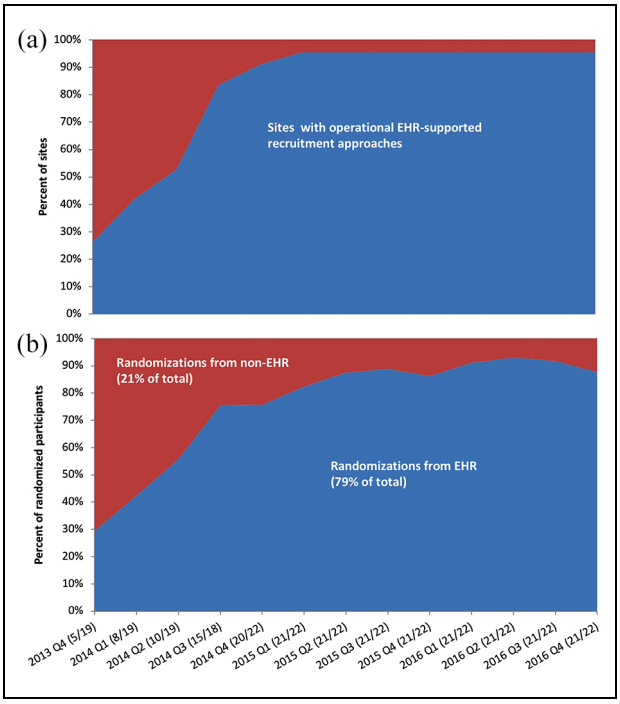

Figure 1. Rate of adoption of electronic health records (EHR)-supported recruitment approaches by clinical research sites (a) and total randomizations study-wide (b).

year of the start of recruitment and was ultimately adopted by all but one site (Figure 1).

Sites developed and employed an IRB-approved, EHR-supported recruitment approach appropriate to each site's local procedures, strengths, customs, and regulations. The key stakeholders for successful implementation of such approaches, their roles, and key lessons learned are described (Text Box 2). The range of required permissions was dictated by the local IRB, institutional leadership, and primary care providers. Forty percent of sites required permission by individual primary care providers before reaching out to patients ("individual clinician engagement"). In the remainder of the sites, research staff obtained system-based permission to contact patients in the local healthcare system unless that patient had opted out of being contacted for research ("system engagement"). Below is a description of these two EHR-supported recruitment models.

EHR-supported approaches directly involving the individual primary care provider ("individual clinician engagement"). Consent of practice leadership was required to query the EHR (some sites required additional consent of the individual primary care provider before querying the EHR); consent of individual primary care providers was required to contact patients. Following approval by the primary care leadership, study staff held face-to-face meetings with primary care providers to inform them of the study and receive their permission to reach out to their patients. Study staff worked with Information Technology/Bioinformatics personnel who queried the EHR of consenting primary care provider panels for patients that met key eligibility criteria (Text Box 1). The query was updated at regular intervals. At many sites, study staff asked individual primary care providers to review the queried list and remove any patients believed not to be good candidates for the study. After a research team member conducted a chart review to confirm eligibility, invitation letters with the electronic signature of the primary care provider were mailed to patients by study staff. The letter briefly described the study and asked patients to contact the study staff (via phone, email, or pre-paid self-addressed postcard) to learn more about D2d. Sites followed letters with phone calls.

In a variation of this approach, one site was required to have the primary care practices conduct the EHR query and initial patient outreach. A designated member (unrelated to D2d) in the administrative office of the primary care group practice queried the EHR. Invitation letters with the electronic signature of the primary care provider were mailed to potential participants by the primary care office. Interested patients then contacted the research team directly to learn more about D2d. The research team reviewed the EHR record only when an interested patient provided verbal consent to do so.

EHR-supported approaches involving the primary care providers at a global level ("system engagement"). Consent of neither practice leadership nor individual primary care provider was required to query the EHR; consent of individual primary care provider was not required to contact patients. Study staff (usually the site principal investigator) informed appropriate system and primary care leadership about the new study, either through in-person meetings or written communications. Permission by individual primary care providers was not required to reach out to patients. Some sites sent primary care providers copies of study information and invitation letters to ensure they were aware of the ongoing recruitment efforts and study details. Study staff worked with Information Technology/Bioinformatics personnel who queried the EHR for patients that met key eligibility criteria (Text Box 1). The query was updated at regular intervals. Patients who had previously requested to not be contacted for research were excluded. Following chart review to confirm eligibility, research staff mailed invitation letters to potential participants. Sites followed letters with phone calls.

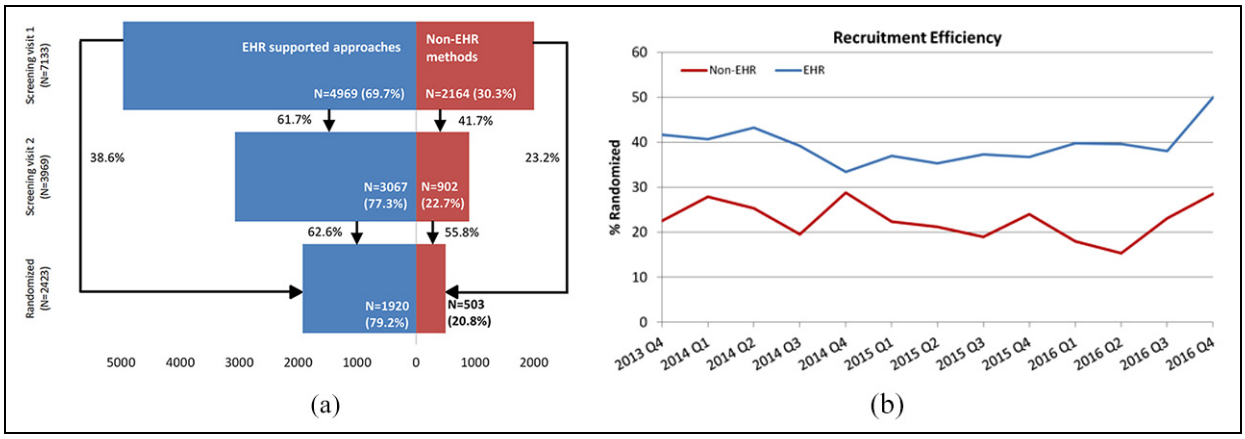

Figure 2. Number of participants screened and recruitment efficiency for EHR-supported approaches versus non-EHR methods overall (a) and over time (b).

Table 1. Participant accrual in D2d study.

	Recruited via EHR	Recruited via non-EHR	p-value
Screening visit 1, n	4969	2164	
Excluded, n (% of those completed screening visit 1)	1779 (35.8)	1180 (54.5)	<0.01
Did not meet preliminary prediabetes criteria	1409 (28.3)	955 (44.0)	<0.01
Ineligible body mass index	54 (1.1)	48 (2.2)	<0.01
Ineligible age	0	4 (0.2)	<0.01
Met exclusion criteria			
Medical condition or medication[a]	38 (0.8)	29 (1.3)	0.02
Vitamin D or calcium supplement use over study limitation	38 (0.8)	29 (1.3)	0.02
Hypertension	51 (1.0)	20 (0.9)	0.69
Poor venous access	21 (0.4)	14 (0.6)	0.21
Abnormal laboratory test[b]	100 (2.0)	45 (2.1)	0.86
Other	68 (1.4)	36 (1.7)	0.34
Eligible after screening visit 1, n (% of those completed screening visit 1)	3183 (64.0)	980 (45.3)	<0.01
Withdrew consent (not interested/declined) prior to screening visit 2, n (% of those completed screening visit 1)	123 (2.5)	82 (3.8)	<0.01
Screening visit 2, n	3067	902	
Excluded, n (% of those completed screening visit 2)	1126 (36.7)	397 (43.9)	<0.01
Did not meet prediabetes criteria	1106 (36.1)	393 (43.5)	<0.01
Hypercalciuria or other reason	20 (0.7)	4 (0.4)	0.48
Eligible after screening visit 2, n (% of those completed screening visit 2)	1939 (63.2)	507 (56.1)	<0.01
Withdrew consent (not interested/declined) prior to randomization, n (% of those completed screening visit 2)	21 (0.7)	2 (0.2)	0.11
Randomized, n (% of those completed screening visit 1)	1920 (38.6)	503 (23.2)	<0.01

EHR: electronic health record.

[a]Medical condition or medication includes: diabetes history (past 1 year) or on hypoglycemic pharmacotherapy, hyperparathyroidism, nephrolithiasis, hypercalcemia, cancer, bariatric surgery, weight management medication, and glucocorticoids.

[b]Abnormal laboratory test includes: hypercalcemia, low glomerular filtration rate, anemia, and abnormal liver test.

Number of participants screened, recruitment performance

Recruitment occurred from October 2013 to December 2016 and 2423 participants were randomized. EHR-supported recruitment contributed a larger number of participants screened than non-EHR methods (4969 (69.7% of the total) versus 2164 (30.3%) Figure 2(a)).

Recruitment performance was higher with EHR, as a larger proportion of screened patients who were identified via EHR-supported approaches were randomized compared to those identified via non-EHR methods (38.6% vs 23.2% respectively; $p < 0.01$) (Figure 2(a) and Table 1). Recruitment performance with non-EHR methods was consistently lower: referrals from clinicians and peer D2d participants, 27%; advertisements, 23%; local research database, 21%; information from "within," 21%; community event, 28%; Internet search by patient, 19%; publicity and news stories, 17%; and other marketing databases, 17%.

Table 2. Characteristics of randomized participants recruited by EHR-supported approaches versus non-EHR methods in the D2d study.

	Recruited via EHR (n = 1920)	Recruited via non-EHR (n = 503)	p-value
Age (years), mean	60.1	56.9	<0.01
Women, %	41	58	<0.01
Hispanic or Latino Ethnicity, %	8	16	<0.01
Race, %			<0.01
White	68	61	
Black or African American	24	31	
Asian	5	6	
Other	3	2	
Smoking, %			0.03
Never	58	62	
Former	36	30	
Current	6	8	
Education, %			0.49
No schooling or less than high school (no diploma or GED)	5	7	
Completed high school	11	12	
Some post-high school education, no certificate or degree	16	15	
Some post-high school education, Associate degree	18	16	
Bachelor's degree	27	26	
Graduate or professional degree	24	24	
Household income, %			<0.01
Less than US$35,000	14	23	
US$36,000–US$50,000	14	16	
US$51,000–US$75,000	17	15	
US$75,001 or more	40	29	
Prefer not to answer	15	18	
Use of vitamin D supplements, %	44	36	<0.01
Use of calcium supplements, %	34	29	0.03
Body mass index, kg/m^2	32.0	32.2	0.40
Hemoglobin A1c, %	5.9	5.9	0.91
Fasting plasma glucose, mg/dL	107.8	108.3	0.23
Plasma glucose 2 h after a 75-g glucose challenge, mg/dL	136.6	139.9	0.05

EHR: electronic health record.
"Other" includes American Indian or Alaska Native, Native Hawaiian or Other Pacific Islander, or Other race. Percentages may not add to 100 due to rounding.

The total number-needed-to-screen per randomization was 2.9. EHR-supported recruitment required 2.6 screened participants per randomization compared to 4.3 participants from non-EHR recruitment methods. Recruitment performance remained higher with EHR-supported versus non-EHR approaches throughout the recruitment period without any significant fluctuation as recruitment progressed (Figure 2(b)). The higher performance was primarily due to fewer exclusions from laboratory prediabetes criteria in the EHR group (28.3% for EHR vs 44.0%, for non-EHR at screening visit 1, $p < 0.01$; 36.1% vs 43.5% at screening visit 2, $p < 0.01$; Table 1). Participants identified by EHR were also less likely to be excluded due to out-of-range BMI, exclusionary medical conditions, or dietary supplement use over study limitation (Table 1). Seventy-nine percent of randomized participants (1920 of 2423) were identified via an EHR-supported approach reflecting the combination of higher number of participants screened and recruitment performance of EHR-supported recruitment (Figures 1 and 2).

Characteristics of participants enrolled from EHR approaches versus non-EHR methods

The mean age of the D2d population was 59.4 years, BMI was 32.0 kg/m^2, and HbA1c was 5.9%. About 45% of participants were women and 43% were ethnic minorities. The subgroup of participants recruited via EHR-supported approaches was slightly older (60.1 vs 56.9 years; $p < 0.01$) and included fewer women (41 vs 58%; $p < 0.01$) compared to non-EHR methods (Table 2). The proportion of racial and ethnic minorities was lower and socioeconomic status was higher among participants recruited via EHR. The subgroup of participants recruited via EHR reported higher use of vitamin D and calcium supplements. Glycemic characteristics did not differ between the two groups.

Discussion

Establishing site-specific EHR-supported recruitment approaches in the D2d multicenter clinical trial was feasible and was instrumental for meeting recruitment targets, accounting for 79% of the study cohort. The D2d experience illustrates research participant recruitment in the "modern era," calling to attention the changing communication landscape and methods of engaging people in clinical research. EHR-supported recruitment in D2d represents a shift toward a more personalized approach to research engagement, directly identifying those via the EHR who have the condition under study and inviting them to consider participating.

Identification of eligible participants from EHR accounted for two-thirds of participants who completed the first in-person screening visit and a higher proportion of screened patients being eligible for randomization. In the D2d study, EHR-based approaches were better than non-EHR methods in identifying participants who were more likely to meet the laboratory-based glycemic criteria. Another advantage of EHR-supported recruitment was the availability of detailed medical history data, which further reduces screen failure rates. Furthermore, through prespecified queries, sites automatically assessed inclusion/exclusion criteria of a very large number of patients with minimal manual work required, offering an inherent efficiency to the pre-screening process.

The larger number of participants screened via EHR-supported approaches coupled with the higher recruitment performance of such approaches led to improved recruitment metrics compared to similar studies. In the D2d study, 7133 participants were fully screened to establish the final cohort of 2423 people with prediabetes, with a majority coming from EHR approaches, for a total randomization ratio of 34% and a number-needed-to-screen of 2.9. In comparison, in the Diabetes Prevention Program study, which relied heavily on more general recruitment approaches in the late 1990s (e.g. direct mail, print, screening events, radio/TV), a total of 158,177 participants were screened to randomize 3819 people with prediabetes for a randomization ratio of 2.4% and number-needed-to-screen of 41.[6]

Although we describe two general models (individual engagement and system engagement), every EHR-supported approach in the D2d study was site-specific in accordance with local procedures, strengths, customs, and regulations. Successful adoption and implementation was possible in diverse clinical environments and required the engagement of multiple local stakeholders with varying degrees of involvement by primary care providers. Several D2d sites developed a directly collaborative model with local primary care providers who saw value in their patients with prediabetes enrolling in a diabetes prevention trial. In these sites, clinician partners provided direct support for D2d recruitment by helping to pre-select patients and by allowing outreach letters to indicate their endorsement of the study. Alternatively, several sites did not require direct engagement and permission of the individual primary care provider. In these sites, which represented larger health systems in which the research endeavors were endorsed by the system (and thus, indirectly, by the clinicians), a system-based EHR-supported approach facilitated recruitment while minimizing burden on clinical workflow and staff. Both approaches conveyed endorsement of the study by the participant's clinical providers.

Outreach and recruitment via EHR may lead to populations with different characteristics compared to non-EHR methods. In the D2d study, the subgroup of participants recruited via EHR was slightly older, included fewer women and racial/ethnic minorities, had higher socioeconomic status, and reported higher use of dietary supplements compared to participants recruited via non-EHR methods. These differences may reflect the characteristics of the population actively engaged with the healthcare system, the higher contribution to the total cohort of the more active D2d sites proficient in EHR-supported recruitment, and inclusion of several Veterans Administration sites, which care for a greater proportion of men. There are likely many other factors at each site that influence the types of patients recruited from each approach. Nonetheless, recognizing that each method likely engages patients with different characteristics (age, sex, race, ethnicity, etc.) highlights the need to include diverse sites and flexible recruitment approaches to ensure generalizability.

To our knowledge, this is the first report to describe operationalization of EHR-supported recruitment across a large multicenter trial, demonstrating feasibility and advantages in outreach, including improved recruitment performance. We describe approaches to implementation and identify key stakeholders for execution of EHR-supported recruitment approaches in diverse clinical settings. While there are reports on individual site success with EHR-based clinical trial recruitment,[9,10] none have reported the broader, centrally supported implementation of EHR-supported recruitment across a multicenter trial, sharing the common requirements for success and approaches for local adoption. Although we describe an EHR-based recruitment approach for a specific clinical trial, such an approach can be applied in clinical practice to reach out and engage people at risk of diabetes for any purpose beyond participation in research.

Some limitations are noted. It is difficult to fully assess the distinct contribution of EHR approaches in the absence of a true control group. For example, site-specific practices that are unrelated to the adoption of EHR-supported approaches, as well as temporal trends, may have influenced recruitment success. However, we expect such factors to have influenced

EHR and non-EHR approaches equally. In the D2d study, uptake of EHR-supported approaches was not required and adoption by sites was "opportunistic," which may have introduced some bias (e.g. sites that were successfully recruiting via non-EHR methods may have delayed adoption of EHR approaches, which may have underestimated the potential of EHR-supported recruitment). In addition, EHR-supported recruitment in the D2d study targeted people with prediabetes, which is defined by specific criteria of common laboratory tests. EHR-supported recruitment may not work as well when eligibility criteria cannot be mapped to EHR data fields, or if these characteristics are not consistently or standardly documented by clinicians.[11]

Conclusion

Establishing site-specific EHR-supported recruitment approaches in a prediabetes multicenter clinical trial was feasible, and adoption by clinical sites was swift. EHR-supported recruitment approaches can be incorporated in diverse environments with varying degrees of involvement of clinical providers. Identification of patients via the EHR followed by outreach is already in place for clinical quality programs and is increasingly being used for population health programs, as exemplified by the Centers for Disease Control and Prevention diabetes prevention program EHR implementation toolkit;[12] thus, clinical EHR identification processes that are already in place may readily be adapted for research engagement. As recruitment methods continue to advance in the current era of evolving technology and personalized medicine, reporting of such methods and sharing of key lessons is necessary to support ongoing and future efforts at patient engagement and evidence generation to advance care.

Acknowledgement

The authors thank the D2d investigators, staff, and trial participants for their outstanding dedication and commitment to the study.

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V.R.A., E.M.V., P.R.S., and A.G.P. contributed to the design, acquisition, and interpretation of data, draft, revisions, and final approval of the manuscript. I.G.B., M.G.O., C.C., R.C., L.S.P., E.S.L., M.A.S., and C.D. contributed to the design, interpretation of data, critical review and edits of the drafts, and final approval of the manuscript.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The planning phase of D2d was funded by the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) through a multicenter clinical study implementation planning grant (U34) to Tufts Medical Center in Boston, MA (U34DK091958; principal investigator A.G.P.). Planning was also supported, in part, by the Intramural Research Program of the NIDDK. The conduct of D2d was primarily supported by NIDDK and the Office of Dietary Supplements of the National Institutes of Health through the multicenter clinical study cooperative agreement (U01DK098245; principal investigator A.G.P.) to Tufts Medical Center where the D2d Coordinating Center is based. The U01 grant mechanism establishes the NIDDK project scientist (M.A.S.) as a member of the D2d Research Group. The study also received secondary funding from the American Diabetes Association (1-14-D2d-01; principal investigator A.G.P.). Educational materials were provided by the National Diabetes Education Program. No pharmaceutical manufacturers contributed to the planning, design, or conduct of D2d. Study pills were purchased from an independent nutritional supplement manufacturing company that has no association with any members of the D2d Research Group. The D2d investigators and the NIDDK project scientist were responsible for the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, and approval of the manuscript; and decision to submit the manuscript for publication.

Role of the funding source

Under the terms of the cooperative agreement funding mechanism used by the NIH, representatives from the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) participated in the design and conduct of the study; interpretation of the data; preparation, review, and approval of the manuscript; and the decision to submit the manuscript for publication. The sponsor did not have the right or ability to veto submission for publication.

Trial registration

ClinicalTrials.gov identifier NCT01942694 (https://clinicaltrials.gov/ct2/show/NCT01942694).

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