A Practical Do-It-Yourself Recruitment Framework for Concurrent eHealth Clinical Trials: Identification of Efficient and Cost-Effective Methods for Decision Making - Part 2

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Abstract

Background: The ability to successfully recruit participants for eHealth clinical trials is largely dependent on the use of efficient and effective recruitment strategies. Determining which types of recruitment strategies to use presents a challenge for many researchers.

Objective: This article presents an analysis of the time-efficiency and cost-effectiveness of recruitment strategies for eHealth clinical trials and describes a framework for cost-effective trial recruitment.

Methods: Participants were recruited for one of 5 eHealth trials of interventions for common mental health conditions. A multi-pronged recruitment approach was used, including digital (e.g., social media, Craigslist), research registry-based, print (e.g. flyers, posters on public transportation), clinic-based (e.g., a general internal medicine clinic within an academic medical center, a large nonprofit healthcare organization), a market research recruitment firm, and traditional media strategies (e.g., newspaper and television coverage in response to press releases). The time costs and fees for each recruitment method were calculated and the participant yield on recruitment costs was calculated by dividing the number of enrolled participants by the total cost for each method.

Results: A total of 777 participants were enrolled in one of the trials. Digital recruitment strategies yielded the largest number of participants across the 5 clinical trials and represented 34% of the total enrolled participants. Registry-based recruitment strategies were in second place by enrolling 28% of the total enrolled participants across trials. Research registry-based recruitment had a relatively high conversion rate from potential participants who contacted our center to being screened to being enrolled, and it was also the most cost-effective for enrolling participants in this set of clinical trials with a total cost per person enrolled at $8.99.

Conclusions: Based on these results, a framework is proposed for participant recruitment. To make decisions on initiating and maintaining different types of recruitment strategies, the resources available and requirements of the research study (or studies) need to be carefully examined.

Introduction:

Recruiting participants into eHealth intervention efficacy trials has long been a challenge [1, 2]. Although internet access has become increasingly widespread and the digital divide has narrowed in recent years [3], difficulties remain in reaching individuals who are interested in taking part in these trials [4, 5]. There are ever increasing ways of recruiting, from older, more traditional methods such as mailing or public print advertising, to newer methods such as social media, and resources such as registries and marketing firms, and each method comes with a set of costs and benefits.

In recent years, difficulties associated with developing and testing new eHealth programs under traditional research grant timelines have been identified [6-8]. Given the focus of the National Institute of Mental Health on information technologies for social and behavioral health [9] and the increase in health researchers who are now capitalizing upon the widespread adoption of personal technologies in attempts to expand the reach and accessibility of behavioral interventions, it is increasingly important that researchers choose efficient recruitment strategies to maximize their research funds and timelines and hit recruitment targets to allow for robust evaluation of program quality, efficacy, and effectiveness. Time and costs required to design and program technologies, as well as the unanticipated, albeit inevitable development problems, often squeeze out time and resources intended for trial recruitment.

The Center for Behavioral Intervention Technologies (CBITs) at Northwestern University recently completed enrollment for 5 simultaneous clinical trials of eHealth interventions for common mental health conditions (i.e., depression and anxiety). To support this enrollment effort, CBITs developed a clinical trial recruitment support system ([10]; co-submitted with this paper and currently under review) and set of recruitment methods that was flexible to the target populations required for each of the trials. This paper presents descriptive information regarding the recruitment strategies employed by CBITs during a nationwide recruitment for eHealth clinical trials, the efficiency of these strategies in producing referred and enrolled participants, and the estimated cost of using these strategies. Given the diverse set of responsibilities needed to successfully employ these strategies, we provide a description of the roles and relevant expertise of our research study staff.

The primary aim of this paper is to propose a decision framework for cost-effective trial recruitment. To support this aim, we describe a set of procedures that were used to recruit and enroll participants across 5 trials using a "do-it-yourself" recruitment support framework (DIY-RSF) described in the companion paper ([10]; co-submitted with this paper and currently under review). We then analyze cost-effectiveness of the recruitment strategies used. Finally, these data, along with lessons learned, are used to propose a framework for recruitment decision-making.

Methods

Study Descriptions

During the recruitment period reported on in this paper, we conducted 3 trials for adults ages 18+ and 2 trials for targeted age groups (i.e., high school students, adults age 65 and older), all of which evaluated eHealth interventions for the treatment or prevention of common mental health conditions (i.e., depression, anxiety) and included a national recruitment strategy. The companion paper by Palac and colleagues [10] also includes a trial that was conducted exclusively in the Chicago area.

The trials for adults age 18+ are described below:

Stepped Care Randomized Controlled Trial (RCT)
The Stepped Care RCT recruited adults ages 18+ who were currently experiencing a depressive episode. Through random assignment, the study compared up to 20 weeks of 1) a telephone-administered cognitive behavioral therapy (T-CBT) and 2) a stepped care intervention that initiated treatment with a coached internet CBT program called ThinkFeelDo, stepping those participants who did not show improvement up to T-CBT (outcome paper currently in preparation). Follow up assessments were administered by phone and online questionnaire up to 2 times during the 20 week treatment period, and at 3 and 6 months post-treatment.

IntelliCare Field Trial
The IntelliCare Field Trial evaluated a suite of 13 Android apps with adults ages 18+ with symptoms of anxiety and/or depression [11]. Twelve of the apps provided different clinical therapy skills for treating anxiety and/or depression, and one app, named the IntelliCare Hub, served as a central place to manage the other apps. All participants used the apps for 8 weeks and were provided with access to a coach via text messaging. Participants completed online questionnaires assessing symptom change and provided user feedback about the apps at 4 and 8 weeks into the study.

IntelliCare Randomized Controlled Trial (RCT)
This RCT continued the evaluation of the IntelliCare platform using a 2X2 factorial design in which participants were randomized to receive 1) coaching or no coaching and 2) automatic weekly recommendations vs. no automated recommendations [12]. Participants were asked to use the apps for 8 weeks, completing two online questionnaires during the active app use study period, and again 3 and 6 months after the end of the 8 week active app use period (primary outcome paper is currently in preparation).

The two trials for targeted age groups, which both utilized a group social networking component, are described below:

ProjectTECH Field Trial
ProjectTECH tested an online and web-app based group intervention for the prevention of teenage depression and substance use disorders [13]. Youth ages 14-19 were placed into peer groups and provided an adapted, responsive version of ThinkFeelDo that was available on phones with age appropriate content and was embedded in an activity feed that supported communication among group members. The peer groups were facilitated by either a clinical

psychologist or a high school student peer guide. Participants were asked to use the web platform for 8 weeks. They were sent online questionnaires at 4, 8, and 12 weeks after beginning the study.

MoodTech Field Trial

MoodTech adapted the ThinkFeelDo program for the treatment of depression among adults aged 65+ [14]. All users had the support of the same clinical psychologist to coach them on how to use the website. Participants were assigned to one of three groups and either had access to a version of the website they could use independently, a version of the website that include peer support features and where they could interact with a small group of their peers, or they were assigned to a wait list control group. Both versions of treatment were 8 weeks long. Follow up assessments were administered by phone and online questionnaires at 4, 8, and 12 weeks after starting to use the website. Participants placed on the wait list prior to using the website and completed 2 additional assessments during the waiting period and then had access to the independent version of the site.

Recruitment Strategies

Participants were recruited for these trials using a multi-pronged approach, including digital (e.g., social media, Craigslist), research registry-based, print (e.g., flyers, posters on public transportation), clinic-based (e.g,. a general internal medicine clinic within an academic medical center, a large nonprofit healthcare organization), a market research recruitment firm, and traditional media strategies (e.g., newspaper and television coverage in response to press releases). Participants self-reported their recruitment source on an initial online screening survey, and recruitment source was clarified when contact was made with study staff.

Staff roles and expertise

Recruitment efforts were conducted under the leadership of an MPH-level research manager (SMK) with experience in community mental health and clinical trial management. This individual managed a team of research staff for the “Clinical Trials Unit” (CTU) which was composed of bachelor’s and master’s level staff. A total of 23 individuals supported study recruitment over the recruitment period, including 3 staff members from Northwestern Clinical and Translational Sciences Institute (NUCATs) who specialized in study screening and were brought on when our team exceeded capacity to manage recruitment and clinical interviews. At the peak of recruitment, there was a core team of 10 CTU staff members supporting recruitment efforts. Most of the research staff members had primary roles as clinical interviewers or technology support specialists on these trials, and managed specific recruitment strategies as a smaller component of their work week. For a 6-month period, a digital marketing manager worked with the Clinical Trials Unit on developing a robust social media strategy focused on Instagram, Facebook, and Twitter.

The recruitment strategies mentioned above directed participants to a centralized online screening survey to be pre-screened for the center’s actively recruiting clinical trials. The online

survey was used to automate initial eligibility decisions, eliminating individuals who would be ineligible for all studies, and allowing research assistants more time to interact with potentially eligible participants and confirm eligibility via a brief phone screener

A master's-level data manager, experienced in programming language for data wrangling, managed the back-end automation and routing of potential participants from various recruitment sources through this centralized online screening survey. For the back-end automation, programming code was written to automatically screen participants for entry into the center's active clinical trials and route to a study based on specific study eligibility, participants' preferred study choice, and the center's recruitment targets for each active study. Code was updated as new recruitment sources were added and center recruitment targets changed. New referrals were processed daily and based on the number of eligible participants received, the data manager notified team members to increase or decrease recruitment efforts, particularly on digital strategies, such as social media ads and research registry pulls. This is described in further detail in Palac and colleagues [10] and was a critical and cost-efficient contributor to the success of the recruitment strategies described in this paper. Because the data component of the framework described by Palac and colleagues [10] was based in technologies already supported by our university (and commonly found at other universities), there were no additional technology costs to maintain this support system.

Recruitment process

Potential participants could contact the center via email, telephone, our web screening survey, or from an in-app interest form. The IntelliCare apps were publicly available on the Google Play Store [15] and people who had already downloaded an IntelliCare app could complete a form within the app that indicated their interest in participating in relevant research projects. These potential participants are labeled as "contacted" throughout this paper. Then, all potential participants went through a brief screening measure and, if initially eligible, were phone screened by a research assistant. These potential participants are labeled as "screened" throughout this paper. Finally, eligible potential participants who passed the two-stage screening and enrolled in one of the 5 clinical trials described above are labeled as "enrolled" throughout this paper.

Data analysis

Descriptive statistics were computed to characterize: 1) the number of potential participants labeled as "contacted", 2) the number of those potential participants labeled as "screened", and 3) the number of participants from each recruitment source labeled as "enrolled". Per-participant costs were calculated for each recruitment method based on a ratio of participant yield to expenditures. The time costs of each recruitment method were calculated based on objective review of study records (e.g. meeting minutes) and through estimates made in consultation with study staff regarding time study staff members spent on the launch and maintenance of each research strategy while it was being utilized. Time estimates were then converted to time costs by multiplying hours spent by the relevant hourly wage (e.g., $17.50 for research assistant time, $30.17 for research manager time). Fees for each of the recruitment methods were calculated based on billing records. Then, the participant yield on recruitment

costs was calculated by dividing the number of enrolled participants by the total cost for each method. This analytic method allows for the identification of methods that were particularly cost-efficient and time-efficient for recruiting eligible participants, while providing transparency into the inner and outer system fees associated with each set of recruitment methods. Results from these analyses are then used to outline a framework for recruitment decision making in the Discussion section.

Results

As shown in Table 1, there was considerable variability in the staff skills and time required to establish and maintain the recruitment strategy.

Table 1. Summary of Recruitment Strategies

	Digital	Registry	Print	Clinic	Firm	Media
Top Performing Sites	Instagram, Reddit, Craigslist	ResearchMatch	Ads on Chicago Transit Autority (CTA) bus and train lines	Health Partners, Group Health	Focus Pointe Global	Unable to be determined
Techniques	Social media marketing, content marketing, direct email, eNewsletters, app advertising, study description on website, blog posts	Email (direct and through web portal) to registry participants	Approximately 800 study-specific banner ads were placed on 2 of Chicago's busiest train lines and on 18 bus routes.	Invitation mailed via USPS, email invitation sent via EMR portal, phone call from research assistant	Email invitation through firm	Planned press release, re-prints
Target Population	US General Public (Adults & Adolescents)	Registry Participants (Adults)	Chicago General Public (Adults)	Individuals engaged in care systems (Adults)	Market Research Firm Panelists (Adults)	US General Public (Adults)
Staff skills required for startup/ management	Social media marketing, analytics, design, public relations (crisis response), REDCap{Harris PA, 2009 #438}	Human subjects recruitment	Design	Project management, relationship management, stakeholder management, database management, human subjects recruitment	Project management, database management, clinical trials recruitment	Public relations, journalism
Management effort	Daily Management	Weekly Management	Monthly Management	Weekly Management	Weekly management	As needed (but labor intensive during initial media blitz)
Resource considerations	Nearly infinite in terms of reach	Finite number of registry participants	Cost prohibitive. University discount made it possible to advertise broadly.	Finite number of patients	Finite number of participants	Nearly infinite in terms of reach

A total of 17,217 potential participants contacted the recruitment site, 2,506 completed screening, and 777 were enrolled across the studies. Table 2 shows the number of potential participants from each recruitment source, who had contact with our research center during the trial enrollment period, varied greatly. The largest portion of potential participants came from an unknown source (i.e., the recruitment source was missing from their record, usually due to the participant's failure to respond to that query) and had contacted the research center through the IntelliCare in-app interest form (labeled IC app/web form in Table 2). This means that these potential participants had already downloaded an IntelliCare app, but we do not know how they first learned about the IntelliCare suite of apps. Among potential participants from a known source, the majority came from digital recruitment strategies (e.g., social media, Craigslist), followed by clinic-based recruitment (e.g., a general internal medicine clinic in an academic medical center, a large nonprofit healthcare organization), research registries (e.g., ResearchMatch.org), print-based advertising (e.g., flyers, posters on public transportation), and media (e.g., news stories prompted by press releases from our research center that included information about ongoing trial recruitment).

Table 2. Potential participants by recruitment source

Raw Numbers	**Digital**	**Registry**	**Print**	**Clinic**	**Firm**	**Media**	**Other**	**Unknown**	**Unknown – IC – app/web form**	**Totals**
Contacted	3318	2030	789	3261	290	297	33	472	6727	17217
Screened	895	627	308	266	138	144	9	33	86	2506
Enrolled	271	225	89	75	55	49	3	6	4	777
Outcomes	**Digital**	**Registry**	**Print**	**Clinic**	**Firm**	**Media**	**Other**	**Unknown**	**Unknown – IC – app/web form**	
% Screened of pts contacted	26.97	30.89	39.04	8.16	47.59	48.48	27.27	6.99	1.28	
% Enrolled of pts contacted	8.17	11.08	11.28	2.3	18.97	16.5	9.09	1.27	0.06	
% Enrolled of pts screened	30.28	35.89	28.9	28.2	39.86	34.03	33.33	18.18	4.65	
% Enrolled of total enrolled	34.88	28.96	11.45	9.65	7.08	6.31	0.39	0.77	0.51	

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The Outcomes section of Table 2 shows that the potential participants, who contacted our center and failed to identify how they arrived at the site (both the "unknown" and the "unknown IC app/web form") had extremely low rates of screening completion (less than 7% for the general unknown category, and less than 2% for those who contacted us through the IntelliCare in-app interest form), while those who identified how they arrived at the site had substantially better rates of web-screening completion, ranging from 8% for clinic-based

recruitment to 48% for media-based recruitment and market research firms, with digital recruitment strategies yielding 27%. The strategies that yielded the highest rates of conversion from contact to screening were the use of a market research recruitment firm (48%), and the use of research registries (31%), which both target individuals who are likely to be interested in research participation. Overall, digital recruitment strategies yielded the largest number of participants across the 5 clinical trials with nearly 35% of the total enrolled participants coming in from digital recruitment strategies. Registry-based recruitment strategies were in second place with by enrolling nearly 29% of the total enrolled participants across trials.

Table 3. Fees and Time Costs for Recruitment Strategies

	Digital	**Registry**	**Print**	**Clinic**	**Firm**	**Media**	**Total**
Fees	$11,726.01	$150.00	$9,318.66	$91,375.00	$31,968.00	$0.00	$144,537.67
Fees per person screened	$13.10	$0.24	$30.26	$343.52	$231.65	$0.00	
Fees per person enrolled	$43.27	$1	$104.70	$1,218.33	$581.24	$0.00	
Time Cost	$8,601.25	$1,872.50	$761.53	$5,767.52	$1,896.52	$935.27	$19,834.59
Time Cost per person screened	$9.61	$2.99	$2.47	$21.68	$13.74	$6.49	
Time Cost per person enrolled	$31.74	$8.32	$8.56	$76.90	$34.48	$19.09	
Total Cost	$20,327.26	$2,022.50	$10,080.19	$97,142.52	$33,864.52	$935.27	$164,372.26
Total Cost per person screened	$22.71	$3.23	$32.73	$365.20	$245.40	$6.49	
Total Cost per person enrolled	$75.01	$8.99	$113.26	$1,295.23	$615.72	$19.09	

Table 3 displays the fees and time costs per person screened, and cost per person enrolled varied considerably across recruitment strategies. During the recruitment period for the 5 clinical trials included in this paper, a total of $144,537.67 were spent on recruitment fees, and there was a total estimated time cost of $19,834.59 for a combined total of $164,372.26. The fees, which included those fees that were paid to enact and maintain the recruitment strategies, ranged from $1 per person enrolled for research registry-based recruitment to $1,218.33 per person enrolled for clinic-based recruitment. The time costs, or research staff hourly wages required to implement and maintain the recruitment strategies, ranged from $8.99 per person enrolled for research registry-based recruitment to $75.01 per person enrolled for clinic based recruitment.

Research registry-based recruitment had particularly low fees (e.g. many registries were free to post in, and nominal fees amounted to $150 total) and had an associated moderate time cost. Because research registry-based recruitment had a relatively high conversion rate from potential participants who contacted our center to being screened to being enrolled, registries have presented as the most cost-effective method for enrolling participants in this set of clinical trials with a total cost per person enrolled at $8.99. However, these registries are typically a finite resource. As recruitment progressed, the research team exhausted the supply of registry participants such that the registries were not accumulating new potentially eligible participants at a rate that kept up with recruitment needs.

Discussion

Results from this set of 5 eHealth intervention trials focused on common mental health problems (i.e., depression and anxiety) indicate that use of digital recruitment strategies (e.g. Facebook, Instagram, Craigslist) and research registry-based recruitment strategies (e.g. ResearchMatch) were the most fruitful, time-efficient, and cost-effective methods for recruiting a nationwide sample of participants. These results add to the literature on clinical trial recruitment methods and the benefits of technology-enabled recruitment strategies. Findings are partially consistent with systematic review results recently reported by Whitaker, Stevelink and Fear [16] on the topic of using Facebook to recruit participants for health research purposes. Whitaker, Stevelink and Fear [16] found growing evidence that, when compared with traditional recruitment methods (e.g., print, radio, email), Facebook recruitment had multiple benefits including lower costs and shorter recruitment periods. However, that review only included one study focused on mental health, and did not examine the utility of other digital recruitment methods, such as Instagram and Craigslist. These results also partially support findings of a scoping review by Topolovec-Vranic and Natarajan [17] in which digital recruitment strategies (e.g., Facebook, Craigslist) were compared with other recruitment strategies for medical research study recruitment. Twelve of the 30 studies included in their review found that digital strategies were more effective than other methods, and an additional 3 studies found that digital strategies were equally effective as another recruitment strategy. However, only 10 of the 30 studies were on behavioral interventions and none of them were on eHealth interventions for common mental health problems. While these studies provide support for the use of digital strategies for medical/health-related study recruitment, they do not reflect the unique nature of recruiting participants with common mental health problems for eHealth interventions. Thus, the results presented in this paper contribute to the broader literature by honing in on this population for eHealth intervention research, and by examining additional recruitment strategies (e.g., Instagram, ResearchMatch).

Results of analyses have been used, combined with research staff experiences, to develop a framework for recruitment strategy decision-making for eHealth interventions, depicted in the questions to guide strategic decision-making presented in Figure 1 and the matrix of recruitment strategy benefits presented in Figure 2. In Figure 2, we have highlighted the recruitment strategies that offer primary benefits of low fees, a high degree of control over the number and flow of referrals being directed to research staff, access to large numbers of people,

access to targeted populations (e.g., with specific clinical diagnoses, with specific demographic profiles), and two benefits associated with easier management/maintenance of the recruitment strategy (i.e., a lack of specialized skills needed, a relatively low burden/time effort for study staff).

Using a variety of recruitment strategies is recommended, and the tools presented in Figures 1 and 2 are intended to help researchers determine the best subset of strategies to use for a particular study or set of studies. To efficiently manage multiple strategies, we recommend implementing a recruitment support framework as described by Palac and colleagues [10], which is structured around an online screening survey and a central tracking database overseen by a data manager. To make decisions on initiating and maintaining different types of recruitment strategies, careful examination of the resources available (i.e., budget, staff, relationships, discounts) and requirements of the research study (i.e., target recruitment number, target participant flow/timeline, entry criteria) is essential. However, prior to reviewing the Figure 1 question set and Figure 2 matrix to determine one's optimal recruitment strategies, one should conduct a literature review to determine if there are relevant studies that suggest what the outcomes or conversion rates for screening to enrollment could be for one's target population using recruitment strategies that may already be under consideration. Early identification of conversion rate estimates for screening to enrollment will help the research team make appropriate time-cost and fee-related investments from the beginning of a trial. If there are not estimates available, then researchers will need to experiment with their selected set of recruitment strategies to fine-tune their approach.

Figure 1. Questions to guide strategic decision-making for recruitment

Resources	
Budget	Do you have a budget for paid advertising? Do you have a budget to support staff to manage the strategy?
Staff – expertise	Can you recruit or train staff to learn skills required to setup/manage this strategy?
Staff - effort	Do you have staff who will be available to establish/manage this strategy?
Relationships	Do you have relationships to establish this strategy?
Discounts	Do you have or can you make connections to reduce the overall cost of this strategy?
Requirements	
Target N	How many people do you need to recruit overall (less than 100, greater than 100)?
Flow/Timeline	How quickly do you need to enroll subjects (months, years)? Do you have enough time to experiment?
Entry criteria	How stringent are your entry criteria (i.e. how targeted do you need to be with your advertising?)

Throughout the question set in Figure 1, one is prompted to consider the existing resources and requirements for a specific study. These resources include available funds (i.e., the budget), staff expertise, staff effort, existing relationships, and access to discounts. Because our research

center was concurrently recruiting for multiple clinical trials, we were afforded some flexibility using recruitment funds to test multiple recruitment strategies and to start and stop the use of those strategies as needed. Further, most research staff members had a primary role as a clinical interviewer or as a technology support specialist on these trials, and managed specific recruitment strategies as a smaller component of their work week. Because research staff employed in a primary capacity for clinical interviewing typically had times during the workday in which no interviews were taking place, there was bandwidth to develop specialized skills and to manage more time intensive recruitment strategies. Thus, the capacity for recruitment strategies requiring specialized skills (such as digital, clinic, and firm-based strategies) and requiring higher levels of effort for management (such as those needed to maintain digital, clinic, firm, and media-based strategies) was already built into the structure of the research team. As seen in Figure 1, study requirements include the target sample size, the target flow/timeline of participants getting screened and enrolled in the study, and the study's entry criteria, which can all be assessed to determine which recruitment strategies are most likely to be fruitful. Studies requiring a large sample size will need to utilize strategies capable of tapping into large numbers of potential participants, and studies that have a limited timeline for recruitment, it will be important to pick a few recruitment strategies and monitor their success closely so that the research team can adjust the strategies as needed. Studies with stringent entry criteria need to be more targeted in their advertising (relative to studies that are recruiting a general adult sample), and this can increase the fees associated with certain types of recruitment (e.g., online advertisements) and increase the time necessary to develop and design appropriate recruitment advertisements.

As identified in our results, the cost-effectiveness and time-efficiency of the recruitment strategies employed varied significantly with digital and registry-based recruitment strategies demonstrating the greatest degree of cost-effectiveness and time-efficiency. This was likely due to the ability of our research team to control the number and flow of referrals using these two strategies, and thus, we were able to get large numbers of potentially eligible participants into our studies in a relatively efficient manner. However, many of the costs presented in this paper are dependent on multiple factors, and thus can be estimated differently based on resources available in different research settings. For example, the expertise that staff members already possess (e.g., social media expertise) can contribute to certain recruitment efforts (e.g., digital strategies) in ways that reduce the need for hiring outside consultants or contractors. Alternately, a lack of these types of internal expertise would not preclude a research team from undertaking these types of recruitment strategies, but could increase the costs of engaging in these strategies as it may be a less efficient use of an staff member's time. Similarly, the existing state of relationships with clinics and healthcare systems can dramatically impact the time costs and fees associated with clinic-based recruitment. Building new relationships takes significant time and strong existing relationships may come with reduced fees within certain clinics and healthcare systems.

Further, recruitment-associated fees can vary depending on existing institutional relationships and access to support such as discounts. For example, the price that our research center paid for recruitment advertisements on public transportation was at a reduced cost due to an

arrangement previously established by our Northwestern University's Clinical and Translational Sciences Institute with the public transportation service. Recruitment-associated fees can also vary depending on changing advertising fee structures and the popularity of keywords used in the advertisements [18] [17]. One recent systematic review on the cost of recruiting for research studies using Facebook found that researchers paid between $1.36 and $110 per completing participant [19]. While the majority of studies (80%) included in this review were cross-sectional surveys and thus those ad clicks were more likely to convert to active study participation compared to intervention studies that last several weeks to months, Thornton and colleagues [19] findings demonstrate the broad range of fees that can be applied to use of a single digital recruitment strategy.

Figure 2. Matrix of recruitment strategy benefits

Benefits	Digital	Registry	Print	Clinic	Firm	Media
Low Fees		x				x
High degree of control (can control number and flow of referrals)	x	x			x	
Broad reach (access large numbers of people)	x				x	x
Access to a targeted population	x			x		
No specialized skills required for maintenance/management		x	x			x
Low effort required for maintenance/management		x	x			

For research studies with a limited staff that are targeting fee-related cost-efficiency, reliance on registry-based and media-based strategies as primary recruitment efforts could prove to be both realistic and successful to hit recruitment targets, provided that the research registries utilized include a feasible number of potential participants (see Figure 2). Print strategies may also be considered for these cases if the research team is able to locate low-cost print outlets that are likely to reach their target population. The use of digital recruitment strategies (e.g. Facebook, Twitter, Instagram) can also be feasible for studies with limited staff if the study team contains at least one individual with a firm understanding of digital marketing, or if there is support for a study team member to develop this expertise. The use of these strategies requires initial management decisions (e.g. reliance on paid ad campaigns versus time developing more robust but free web-presence) but can be designed to require less staff time than was used by our group while still allowing researchers to draw from a very large number of potential participants and exert a high degree of control over the flow of potential participants from targeted populations.

Our personnel cost estimates are pulled from a private university in a large Midwestern city, and may not accurately reflect payrates in other areas of the United States or in other cities around the world conducting similar research. Indeed, clinical research costs are largely driven by personnel-costs and these costs can be substantially lower or higher in other locations where similar research could feasibly take place [20]. Some researchers may struggle with personnel-related decisions due to financial costs, and we note that having an experienced research manager can be more costly upfront, but has the potential to save money over time due to skill

at managing other research staff time and at negotiating relationships with new recruitment partners. This was particularly important during the set of trials used in this paper, as our experienced research manager was key in negotiating and navigating relationships and keeping recruitment targets on track to ensure that money was being well spent. This tracking system is further described in our companion piece by Palac and colleagues [10].

We found that digital and research registry-based recruitment strategies brought in a faster flow of participants than other strategies examined, and that this can be particularly useful for studies with a limited recruitment timeline. This is partially consistent with past review papers on using social media for research recruitment [16] [17]. While digital strategies can be designed to tap into a growing audience through slight shifts in targeting, strategies such as clinics and research registries may limit recruitment efforts as they tend to have a relatively fixed number of potential participants. Not surprisingly, the recruitment strategies used and their relative success varied by target population. While recruitment using digital and research-registry based strategies were similarly successful in our studies of general adults samples, some differences were noted in our studies focused on specific age groups. In our ProjectTECH study of high school students [13], the vast majority of participants were recruited through Instagram, as social media platform that was particularly popular with teenagers during the recruitment period. In the MoodTech study for older adults [14], recruitment via digital platforms was less successful, and the vast majority of participants were recruited through the ResearchMatch.org registry.

To our knowledge, the time-efficiency and cost-effectiveness of research registry-based recruitment for eHealth interventions has not previously been reported upon and compared to other methods of recruitment such as digital strategies and more traditional strategies such as clinic-based recruitment and print advertisements. Results of this study suggest that, as the most cost-effective method of recruitment that also yielded a high percentage of eligible participants, researchers should strongly consider strategies such as the ResearchMatch.org registry to identify individuals who are likely to be interested and eligble for their eHealth intervention studies. The use of research registries appears to be far more efficient and inexpensive compared to print advertisements, recruitment firms, and clinic-based strategies. However, given that research registries are typically drawing from a finite group of potential participants, the use of supplementary recruitment strategies is valuable.

Research Considerations

An issue that emerges here is the denominator problem, previously discussed by Mohr and colleagues [21]. The denominator problem notes that most eHealth interventions recruit from very large pools of potential participants, and thus those individuals who choose to participate in an eHealth program are likely uniquely motivated. While this paper focuses on recruitment for early efficacy trials of eHealth programs, we note that the time-efficient and cost-effective recruitment strategies discussed in this paper may further contribute testing eHealth interventions on the select group of individuals in the general population who are likely to engage and benefit from these interventions. A broader use of recruitment strategies produces the possibility of a wider range of participants, but this does not necessarily solve the

denominator problem. As the goal of eHealth program development is to ultimately have the potential for larger scale implementation and public health benefits, an exclusive focus on recruiting for efficacy trials is likely to have a detrimental impact on the potential for developing programs to be successfully implemented. Thus, researchers may be wise to consider at least preliminary assessment of implementation factors in early evaluations of eHealth interventions, following the guidelines for Type I hybrid trials described by Curran and colleagues [22].

While findings indicate that clinic-based recruitment strategies were expensive and inefficient in this set of trials, we do not conclude that researchers avoid partnerships with clinical care settings when evaluating eHealth interventions for common mental health problems. Rather, the data presented here demonstrate that digital and research-registry recruitment strategies are efficient and relatively inexpensive for enrolling participants in these types of studies. For researchers focused on bringing their eHealth programs into clinical practice settings, the additional time and effort needed to enroll participants from a clinical practice setting is vital and will come with valuable insights into barriers and facililators to larger scale program implementation. To maximize time-efficiency and cost-effectiveness, the strategies described in this paper should be used in tandem with clinical trial recruitment support systems focused on pre-screening referral (as described by Palac and colleagues, [10]).

Limitations

The examination of recruitment strategy efficiency and cost-effectiveness, and the resulting decision-making framework presented in Figures 1 and 2, are not without limitations. This was based on a limited number of clinical trials of eHealth interventions for common mental health conditions. However, the recruitment principles listed within this paper are likely generalizeable to clinical trials focusing other types of digital behavior change and health interventions. Further, the time spent on various recruitment efforts was not closely tracked during these trials, and thus the time costs of many strategies were estimated through a combination of objective review of study records (e.g., meeting minutes) and through estimates made in consultation with study staff regarding time study staff members spent on the launch and maintenance of each research strategy while it was being utilized.

Another limitation of this study is the large percentage of potential participants who came from unknown sources, and after completing an in-app research interest form, did not proceed with screening. Media-based recruitment, in which press releases from our research center included information about ongoing trial recruitment, initially appear to be a relatively low cost recruitment strategy. Yet, many of these “unknown” participants contacted our research center following periods of media coverage, and while we can hypothesize that a sizeable portion of these individuals learned about our trials and downloaded one or more IntelliCare apps through media coverage, we cannot substantiate this hypothesis. While it is clear that media coverage generated a small stream of referrals who went on to complete screening and enroll in the study, the influx of potential participants (many of which are labeled as being from unknown sources) contacting our research staff following press releases required a fairly high management effort by study staff.

This decision making framework is less relevant if it is important for an intervention to be tested within a specific clinic. In those cases, the recruitment strategies will have to be focused within the clinic and recruitment timelines and budgets will have to be established to account for a potentially slow recruitment speed/low recruitment yield, and to account for what could be substantial time costs and fees associated with establishing the clinic relationship, navigating acceptable referral methods, and advertising to clinic patients (e.g., mailing study advertisments to all potentially eligible patients within clinic can be high cost and low yield, while personnel time required to conduct daily chart review and identify potentially eligible participants to approach may be more fruitful). These barriers to quick recruitment in clinic settings have been well documented previously, and must be planned around [23] [24]. For a review of best practices in study site selection and recommendations to plan efficient recruitment efforts in these clinical contexts, see Huang and colleagues' recent paper on the Clinical Trials Transformation Initiative [25]. More commonly, eHealth interventions are being tested for efficacy and can draw from a broader pool of potential participants. In these cases, the framework can be used to evaluate the resources available and the requirements (i.e., main aims and constraints) of the study.

In spite of these weaknesses, in tandem with the system described by Palac and colleagues [10], this is the first framework for designing and monitoring recruitment efforts for eHealth clinical trials. This framework can be used by fellow researchers to make recruitment decisions at the outset of an eHealth clinical trial to target a set of efficient and cost-effective recruitment efforts, and can be used as recruitment needs and priorities may shift over the course of a clinical trial.

Conclusions

In our study, digital and research registry-based recruitment strategies are more efficient and cost-effective for engaging potential participants in trials evaluating eHealth interventions aimed at common mental health problems (i.e., depression, anxiety) when compared to traditional recruitment strategies, such as print-based advertisements and recruitment from within clinical care systems. These results also demonstrate how a DIY recruitment framework can be used to track recruitment success and cost-effectiveness and support recruitment strategy decision making. These methods, along with the topics proposed in the recruitment strategy framework, should be considered by researchers when designing their recruitment strategies, with specific focus on the overarching aims of the study (e.g. getting participants in quickly to test an intervention, compared to focusing on how an intervention would fit into a specific clinical care setting).

Acknowledgements

The intervention studies included in this paper were supported by research grants from the National Institute of Mental Health (P20 MH090318; R01 MH095753; R01 MH100482) to David C. Mohr, Ph.D. Dr. Emily Lattie is supported by a research grant K08 MH112878 from the National Institute of Mental Health. Recruitment methods cited in this paper included use of ResearchMatch.org, a national health volunteer registry supported by theNational Institutes of Health as part of the Clinical Translational Science Award (CTSA) program is funded by grants

UL1TR000445, U24TR00157 9, and 5 U24 TR001579-02, and the Aging Research Registry, a database of approximately older people in the Chicagoland area who have expressed a willingness to participate in research studies on the provision of care to aging patients and that was created and is supported by Northwestern University's Buehler Center on Aging, Health, and Society. The authors wish to thank the volunteers who have participated in research through the Center for Behavioral Technologies (CBITs).

Conflicts of Interest

Dr. Mohr has accepted consulting fees from Optum Behavioral Health, and has an ownership interest in Actualize Therapy. Dr. Lattie has accepted consulting fees from Actualize Therapy. None of the other authors have any conflicts of interest to declare. Hannah Palac is currently employed by AbbVie, Inc. Contributions to the recruitment framework described in this manuscript were made while she was employed by Northwestern University.

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