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Implementation science approaches for integrating eHealth research into practice and policy

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ABSTRACT

Purpose: To summarize key issues in the eHealth field from an implementation science perspective and to highlight illustrative processes, examples and key directions to help more rapidly integrate research, policy and practice.

Methods: We present background on implementation science models and emerging principles; discuss implications for eHealth research; provide examples of practical designs, measures and exemplar studies that address key implementation science issues; and make recommendations for ways to more rapidly develop and test eHealth interventions as well as future research, policy and practice.

Results: The pace of eHealth research has generally not kept up with technological advances, and many of our designs, methods and funding mechanisms are incapable of providing the types of rapid and relevant information needed. Although there has been substantial eHealth research conducted with positive short-term results, several key implementation and dissemination issues such as representativeness, cost, unintended consequences, impact on health inequities, and sustainability have not been addressed or reported. Examples of studies in several of these areas are summarized to demonstrate this is possible.

Conclusions: eHealth research that is intended to translate into policy and practice should be more contextual, report more on setting factors, employ more responsive and pragmatic designs and report results more transparently on issues important to potential adopting patients, clinicians and organizational decision makers. We outline an alternative development and assessment model, summarize implementation science findings that can help focus attention, and call for different types of more rapid and relevant research and funding mechanisms.

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1. Background

There is consistent and increasing evidence that eHealth interventions are efficacious [1–4] For the purposes of this paper, we define eHealth interventions as "the use of emerging information and communication technology, especially the Internet, to improve or enable health and health care" including Internet, interactive voice response (IVR), automated and electronic programs, CD-ROMS, mobile applications, and computer-tailored print but exclude telemedicine and interventions targeted solely at clinicians that do not have a patient or consumer facing interface [5]. Despite the consistent evidence documenting the superiority of eHealth interventions over no treatment or usual care conditions, a number of questions still remain including their generalizability,

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cost-effectiveness, and the conditions under which they are more and less effective [1,6,7].

The widespread use and integration of eHealth interventions into routine care and health policy remains a challenge. There are exceptions, but in general, most published research on eHealth programs is conducted in academic settings or unaffiliated with any delivery system and the intervention is no longer supported when the funding supporting the study expires. As of this writing, both the US Food and Drug Administration and the Office of the National Coordinator for Health Information Technology are currently examining the need for regulation regarding eHealth; but it is unclear whether this will extend beyond certification processes of interacting applications with electronic health record technology or medical device regulation.

From a systems persepctive [8,9], it is also important to consider potential unintended consequences of eHealth interventions which may include exacerbation of health inequities, failure to reach those most in need, or negative impact on those who self-disclose. However, it is unclear if these unintended consequence are any worse than for other modalities including face to face or group programs, or if they occur at a greater frequency [10,11]. Earlier concerns that low-income or other disadvantaged groups would have less access to and particpate less in eHealth interventions than other subgroups have proven to be lagely unfounded, especially with the advent of mobile phone interventions [12]. The point, however, is that there is still much that is unknown about unintended consequences from eHealth interventions.

Implementation science (IS) can address the above issues by studying the multi-level eHealth implementation context [13], participatory implementation process [14], and intervention effects. Harmonized practical measures [15,16] and IS models and frameworks can be used in the design and evaluation of eHealth interventions to better understand contextual and setting factors, employ more responsive and pragmatic designs, and report results and issues important to potential adopting patients, clinicians and organizational decision makers [14,17–19]. Additionally, the surge of eHealth technology and development of new innovations far outpaces traditional research trajectories. As can be seen in Fig. 1a [20] (modified from Riley et al., in press) the typical research timeline in eHealth and most other scientific areas, is relatively slow and incongruent with the speed of technological advancement. Currently, an eHealth grant funded under standard NIH mechanisms (optimistically assuming funding upon the initial submission) would take a total of approximately 6–7 years before publications are available. The content of this research is likely to be considerably dated, if not rapidly obsolete. As exhibited in the figure, many fundamental innovations and widespread platforms would not be possible to study given the current research timelines.

The purpose of this paper is to (1) propose a more rapid research paradigm to produce and evaluate ehealth interventions more likely to translate into practice; (2) summarize key issues from IS including potentially applicable models, practical study designs, and measurment issues relevant to eHealth; (3) highlight exemplary studies; and (4) make recommendations for future ehealth research, practice and review mechanisms.

2. The need for speed: a Rapid and Relevant Research Paradigm

It is possible to conduct research much more rapidly thereby simultaneously increasing relevance and making it more likely that results will translate into policy and practice.

Fig. 1b displays a more rapid and relevant intervention development approach that may be particularly relevant to eHealth research given the fast pace of technological development, data volume collection capabilities and potential for eHealth to reach a broad range of people. This paradigm would allow for dissemination of eHealth interventions into practice at a much quicker pace than current research mechanisms. However, it requires researchers to consider dissemination and implementation during research development use non-traditional study designs and continuously evaluate [18,21].

The first step in this paradigm is to simultaneously conduct a rapid literature review and "environmental scan" of practice-based and industry examples of best practices [22]. An important second step in this rapid research paradigm is rapid prototyping and refining. This involves, first, synthesizing the results of the rapid literature review and needs assessment using evaluability procedures as described by Leviton et al. [23] to gauge whether programs or interventions identified have realistic chances of being widely adopted or succeeding under real world conditions before investing substantial dollars and years testing. These evaluability activities would be followed by multiple, small rapid experiments with diverse patients in diverse settings using alternative research designs to both quickly test and continuously refine eHealth interventions, with the focus on reaching a point where consistent results are found.

The final step prior to broad scale dissemination would be to test the resulting programs within practical or pragmatic study designs/trials in diverse settings [16,24,25]. The focus of pragmatic studies is to address research questions that are relevant to stakeholders and to include diverse settings, conditions of administration and populations; assess costs and resources required and contextual factors that may be related to intervention outcomes and report unintended consequences [24,26]. After an eHealth intervention has been replicated and tested in diverse settings, the final step is dissemination into practice. During this phase, it is important to continuously monitor the eHealth intervention's effectiveness, ways to improve its quality and to build in alerts if the intervention is no longer working. eHealth interventions may be best sustained within supportive and collaborative communities of practice.

As shown by the recursive arrows in the figure, this is NOT a linear process, but a cycle of innovation and rapid testing. Findings relative to processes, outcomes or new external developments can trigger cycling to other phases. The time required to move from the needs assessment and identification of exemplars to dissemination into practice will vary widely depending on the intervention, context, demand, results and a variety of other factors including cost, stakeholder support and research team but can be completed within 1–2 years as depicted in Fig. 1b as compared to the 7 plus years in Fig. 1a. Table 1 details the comparisons of the

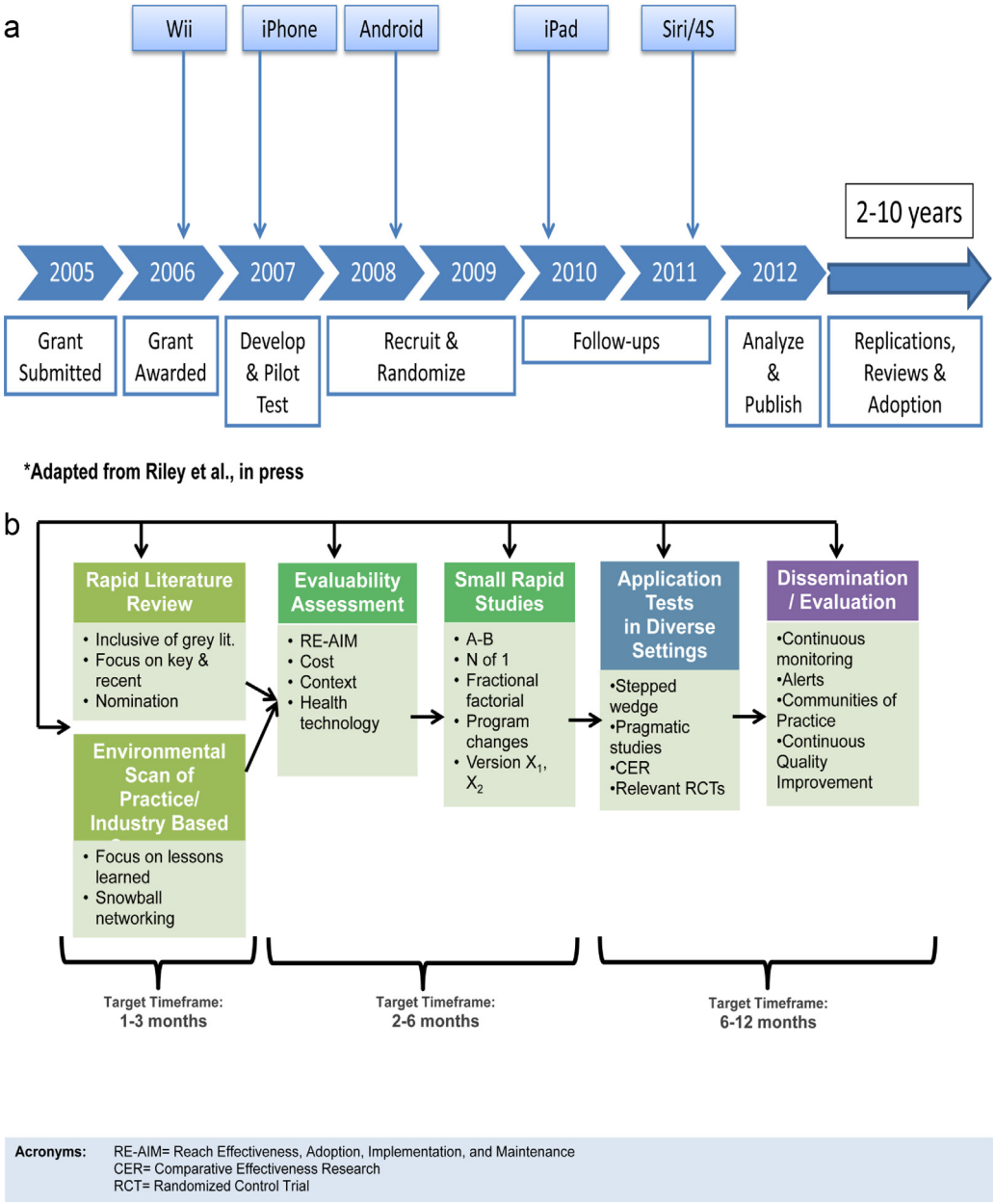

Fig. 1 – (a) The Traditional Slow Research Paradigm. Adapted from Riley et al. [20]. (b) Rapid and Relevant Research Paradigm. *Acronyms*: RE-AIM: Reach Effectiveness, Adoption, Implementation, and Maintenance; CER: comparative effectiveness research; RCT: randomized control trial.

Table 1 – Comparisons of traditional research pipeline with rapid, relevant research process.

Issue	Traditional pipeline	Rapid, relevant research process
Speed	Slow to very slow	Rapid, especially early on
Intervention and "protocol" flexibility	"Frozen" early and standardized	Iterative, evolves, adaptive
Adaptation	Seen as bad—compromise to integrity	Encouraged and necessary to "fit"
Designs Used	Predominantly RCT	Several, interactive, convergent
Cost and Feasibility of Research and Products Produced[a]	Not considered, usually high	Central throughout; "MINC"[a] approach; considered before, during, and after
Stakeholder Engagement	Little and usually only respond to research ideas	Throughout, essential
Reporting	CONSORT criteria, primary outcome, little else	Broad, transparent, perspective of adoptees
Role of Context	De-emphasized, assumed independent of context	Context is central, critical and studied

[a] MINC: Minimal Intervention Needed for Change.

traditional research pipeline with the proposed research process on several elements relevant to integration of eHealth interventions more rapidly into practice. Key differences are that the more rapid development approach involves designing for dissemination from the outset [27]; considers issue of cost, context and feasibility throughout; and considers development and adaptation an ongoing iterative process, rather than identifying an efficacious intervention and then "freezing" the program thereafter. IS science models, methods, and measures discussed in further detail below are used to facilitate this research timeline and enhance the potential of eHealth interventions to have widespread impact in clinical and public health practice.

3. Implementation science models

Over 60 IS frameworks have been developed to address health services across a wide diversity of issues [17] and can be used to help design more rapid and relevant research. Reviews have analyzed these conceptual and theoretical models with mixed findings regarding development of theoretical concepts, methods, and measures available for direct application [17,28–31]. IS frameworks are increasingly applied and widely adopted in health service research. However, to our knowledge no IS model specific to eHealth exists; and no one model systematically incorporates methods related to external validity, the importance of practical measures [16], rapid development and implementation [20], iterative adaptation processes, continuous monitoring of progress, and patient-centeredness. In the absence of eHealth models that addresses all these issues, we highlight four models especially relevant to eHealth research. These include the: (1) Evidence Integration Triangle [14]; (2) Expanded Chronic Care Model [32]; (3) Health Literate Care Model [33]; and (4) RE-AIM [34].

3.1. *Evidence Integration Triangle*

The EIT [14] is a simple framework for studying the complex multilevel contextual factors affecting the integration of scientific knowledge into practical applications. The EIT has three main components—and evidence-based intervention program or policy, partnership implementation processes, and standardized, practical measures of progress, all of which interact within the multilevel context surrounding a specific health problem and intervention. The model promotes an iterative process between large-scale dissemination and ensuring that local EIT implementation activities are coordinated to support each other while being flexible and adaptable to the implementation context. One study currently applying EIT is the My Own Health Record (MOHR) project designed to rapidly evaluate a flexible, pragmatic patient-centered primary care implementation system. MOHR is implementing patient-reported measures to support consistent identification of and counseling on health behavior and mental health issues recommended by the USPSTF in diverse real world settings [25].

3.2. *Expanded Chronic Care Model (CCM)*

The Expanded CCM integrates population health promotion with the prevention and management of chronic disease. The original CCM facilitates quality improvement processes for clinical teams focused on interventions to address six interrelated health systems areas: self-management support, delivery system design, decision support, practice design, organizational support, and clinical information systems [35]. Evidence supports the widely adopted CCM as an integrated framework to guide practice redesign and leads to improved patient care and better health outcomes [36]. The expanded CCM broadens the CCM by integrating population health promotion and support into the original clinically focused model. The Expanded CCM supports the intrinsic role that social determinants of health have on individual, community, and population health behaviors and strengthens opportunities for community action, building health public policy and creating supportive environments [32]. An example of effectively using IS methods to integrate mobile health technology using existing health system resources to support the CCM is the diabetes self-management program being implemented in the University of Chicago Health Plan [37].

3.3. *Health Literate Care Model*

The Health Literate Care Model (HLCM) recently proposed by Koh et al. [33] builds on the basic principles from the CCM of patient engagement by systematically incorporating health literacy strategies. The HLCM offers opportunities for systems change by proposing all health care contacts approach patients with the assumption that they are at-risk for not understanding their health condition or how to improve or maintain their health. This patient-centered approach extends to all six CCM elements above including community partnerships. Although interventions based on the recently proposed HLCM do not yet exist, the AHRQ has developed a suite of universal precaution literacy tools to incorporate health-literate approaches to better inform and engage patients in their care and drive systems change [38,39].

3.4. *RE-AIM*

The RE-AIM model has been widely used to plan, evaluate and review health promotion and disease management interventions [40,41]. RE-AIM is a conceptual model designed to enhance the quality, speed, and public health impact of efforts to move from research into long-term effectiveness in real-world settings. It may be particularly useful for increasing the potential of eHealth interventions intended to be translated into practice [1,42,43]. RE-AIM consists of five evaluative dimensions related to both internal and external validity: Reach, Efficacy/Effectiveness, Adoption, Implementation, and Maintenance and is intended for use at all stages of research, from planning to evaluation. The use of these five dimensions can address key issues in research translation and increase the probability that interventions can be implemented and sustained in a large number of settings.

There have been an increasing number of eHealth interventions using the RE-AIM dimensions in their design [44]

and evaluation [45]. The web-based patient assessment and support resource *Connection to Health* Patient Self-Management System, was specifically developed using the RE-AIM model by employing strategies to increase reach (e.g., different modalities), effectiveness (e.g., using evidence-based intervention strategies), adoption (e.g., assistance in integrating the system into practice workflows and allowing for local customization), implementation (e.g., targeting actionable priority issues for patients and healthcare teams), and maintenance/sustainability (e.g., integration with clinical pathways of care). Glasgow, et al. [46] have recently used the model to address health disparities in the context of a combined web and IVR-based intervention.

4. Rapid learning methods for eHealth research

To increase research that is not only rigorous but rapid, relevant, robust, recursive and transparent [47], there is a need for more pragmatic "rapid-learning research systems" that integrate relevant stakeholders (e.g., researchers, funders, health systems, and community partners) with clinically relevant research questions, use efficient and innovative research designs, and leverage rich, longitudinal data sets [20,48,49]. Rapid learning methods involve evaluability assessments [23] to assess the feasibility of implementing and sustaining an eHealth intervention during the early research and development phases and rapid, adaptive studies to quickly determine the optimal eHealth intervention components.

4.1. *Evaluability/Health Technology Assessment*

Evaluability assessment identifies key resources, contextual factors, and anticipated challenges of implementing a particular technology prior to conducting a study [23] and can further optimize research activities by considering important elements of IS models including RE-AIM elements, costs, sustainability and context. Evaluability assessment can be used in conjunction with Health Technology Assessment (HTA) [50] which examines and reports properties of the technology itself, including safety, efficacy, feasibility, and indications for use, cost, and cost-effectiveness, as well as social, economic, and ethical consequences of its use, whether intended or unintended. HTA may be particularly useful during the rapid prototyping and refining phases by providing continuous feedback on specific characteristics of the technology that need to be corrected and to facilitate and monitor appropriate introduction and use of new eHealth interventions [51,52] by ensuring their safety, effectiveness and feasibility [53]. More technology focused HTA can be used with more implementation focused evaluability assessment to facilitate dissemination of technology into practice

4.2. *RE-AIM assessment*

RE-AIM can be used during the early phases of eHealth interventions to ask questions that may influence dissemination into practice including:

(a) What percent and what types of patients are likely to receive the program?
(b) For whom is the intervention effective? For what outcomes, with what broader effects and potential negative consequences?
(c) What percent and what types of setting and practitioners are likely to adopt this program?
(d) How consistently are different parts of the program likely to be implemented across settings, clinicians and patient subgroups? At what cost?
(e) How well is the eHealth program and its effects likely to be maintained? [1].

Researchers should consider these questions along with the goals of relevant stakeholders as they proceed through intervention design to increase chances that program deemed effective will be adopted, successfully implemented and sustained.

4.3. *Cost and economic assessments*

The costs of eHealth programs are seldom reported in the research literature [54]. This is unfortunate because costs and resources required are usually the first question that decision makers in settings considering adoption ask. Comprehensive economic analyses such as estimating long terms costs and benefits from a societal perspective can be quite complex, time consuming and themselves expensive [55]. In contrast, tracking implementation costs of delivering an eHealth program and estimating replication costs of delivering the program under different conditions is possible in most studies as exemplified by Ritzwoller et al. [56].

4.4. *Contextual assessment*

Another key element of IS methods involves consideration of contextual factors [13]. Researchers in eHealth should conduct multiple assessments of contextual factors to help distinguish conditions under which a particular intervention or technology does or does not work. Key contextual factors that can impact the effectiveness of eHealth interventions include other intervention components (e.g., amount and timing of human to human interactions; use of other interventions recommended and not), competing demands of both consumers and practice settings, specific setting or technology characteristics (e.g., level of personalization, type of device used, etc.) and level of social environmental supports. Often, a mixed methods approach is particularly useful to better understand what works for whom under what conditions.

5. Rapid, adaptive designs

Insights from evaluability assessments inform prototypes and quick refinements of eHealth intervention components as discussed above. Several optimization approaches adapted from industry and engineering may be particularly useful to quickly test and refine eHealth intervention components [58], including dynamic systems models [59], N-of-1 [60,61],

A–B quasi experimental [62], multiphase optimization strategies (MOST) [63], and sequential multiple assignment (SMART) [63]. These trial designs are rigorous and allow for rapid studies to identify and adapt the most ideal and effective eHealth interventions. These methods have the ability to answer the "what works?" question by helping to identify which combination and/or sequence of intervention components optimize outcomes [64]. They also do it at a pace that may allow for eHealth interventions to be implemented into care before the delivery technologies are obsolete and such methods have been recommended in place of traditional pilot trials [20]. Additionally, these designs are iterative, flexible to demands of real-world settings, and can ultimately reduce the need for much more lengthy and expensive large trials.

Findings from rapid, adaptive studies can be used to identify elements of eHealth interventions that are most effective and should be rolled out and tested on a larger scale to determine whether findings can be replicated in diverse, real-world settings.

6. Comparative effectiveness research (CER)

The Institute of Medicine defines CER as "the generation and synthesis of evidence that compares the benefits and harms of alternative methods to prevent, diagnose, treat and monitor a clinical condition, or to improve the delivery of care" with the goal of assisting consumers, clinicians and policy makers to make informed decision that will improve healthcare [65]. eHealth may be optimally suited for CER because a wealth of relevant data can be collected quickly to compare outcomes between two interventions integrated into real world settings to determine whether one is preferable in terms of effects and intervention characteristics (e.g., staff burden, cost, ease). In addition, electronic health records can increasingly be used to collect relevant data for comparing two interventions, thus substantially reducing assessment burden. Patient-centered eHealth interventions seem especially good candidates for applications to the new Patient Centered Outcomes Research Institute [66].

7. Pragmatic trials

Pragmatic trials evaluate the effectiveness of interventions in real-life routine practice conditions in order to maximize applicability and generalizability, and seek to maximize heterogeneity in all aspects (participants, staff, settings) [24,26,67]. Pragmatic trials are used to address questions relevant to, and informed by, stakeholders and use comparison conditions that are real-world alternatives. The pragmatic-explanatory continuum indicator tool (PRECIS) [24] can be used to evaluate the extent to which trial designs are pragmatic or explanatory along key dimensions, have dissemination potential, and to assess pragmatism of ongoing studies. It can also be used to evaluate finished projects or conduct systematic reviews of published research [54,68,69].

8. More relevant RCTs

Dismantling and stepped-wedge [70] designs, and modifying follow-up periods can be used to enhance the relevance of traditional RCT designs. Dismantling designs, particularly, The Minimal Intervention Needed for Change comparison conditions (MINC) [71,72] can be used to find low cost, minimally intensive interventions that improve outcomes. Stepped-wedge designs maximize statistical power because the intervention effect is estimated by both between-cluster and within-cluster comparisons and can be particularly useful during phased implementation [70] as it allows for improvement of the intervention or its delivery where necessary before the next implementation phase [73]. In addition, RCT follow-up periods can be shortened or segmented so that results can be analyzed at the point where the maximal benefit of the intervention is hypothesized to occur, and longer-term outcomes can be modeled or one of the investigators can be blinded to conduct the follow-up portion of the study and publish these results separately [20].

9. Practical harmonized measures

Two classes of measures are relevant to this discussion: "gold standard" and "practical." "Gold standard" measures are recommended for primary outcomes in grants and are most useful with large resources and staff to ensure quality while "practical measures" are often necessary for applied research in busy, low-resource settings or in cases when large amounts of data are being collected and brief and feasible measures on multiple issues are the primary goal. Regardless of the type of measure used, most studies use different and often idiosyncratic measures specific to the study at hand or system being used to assess key constructs [15]. The lack of standard or more harmonized measures, for example of consumer engagement in eHealth [74] makes it difficult to conduct systematic reviews, research syntheses, and comparisons across studies. One initiative funded by the National Cancer Institute to increase data harmonization and access to valid and reliable measures is the Grid-Enabled Measures (GEM) Database which provides access to both patient reported measures and measure of IS constructs which can be used across broad settings [15] (http://cancercontrol.cancer.gov/brp/gem.html). While "gold standard," traditional measures are relevant to eHealth interventions, much of the data collected are measured in real-time and either are automatically and unobtrusively collected in the technologies used in eHealth interventions (e.g., website tracking) or need to be brief, practical measures that are feasible to collect in busy health care settings [e.g., electronic health records (EHRs)].

9.1. *Automated measures*

Most EHR systems generate vendor and institution-centric data and measures limiting their utility to integrate data and patient information [81]. Meaningful use criteria should strive for common measures of patient-reported outcomes [82] as

Table 2 – Examples of implementation science principles and findings.

Issue/finding or principle	Study	Study description
Address context (including policy); involve stakeholders throughout	Krist et al. [25]	Pragmatic implementation design testing the implementation of psychosocial and behavioral measures into primary care EHRs across 18 diverse sites incorporating adaptations specific to each site.
Use implementation theory or model	Nundy et al. [37]	Report on the iterative process undergone to develop a text message-based diabetes self-management program to be implemented in the University of Chicago Health Plan including setting, pilot testing, content development and stakeholder engagement.
Use implementation evaluation model	Glasgow et al. [46]	Used RE-AIM to design and evaluate *Be Fit, Be Well* a randomized web or telephone-based weight and hypertension self-management intervention for urban community health center patients.
Report transparently on D & I issues	Damschroder et al. [31]	Used a model of complex implementation to understand contextual factors that influenced implementation effectiveness the MOVE!® Weight Management Program into Veteran Affairs using mixed methods and report on issues that influenced successful implementation in different settings.
Design matches the question; use of rapid, adaptive study design	Strecher [3]	Used a MOST design to test 5 different potential active components (self-efficacy, outcome expectations, success stories, message source, and message exposure) and tailoring depth of a web-based internet smoking cessation in combination with a nicotine patch on 6 month smoking cessation.

well as demographic and health literacy/numeracy variables [75]. Harmonized measures facilitate meta-analytic opportunities for more integrative HIT eco-systems for consumer health and allow for the inclusion of data from public health and geospatial surveillance systems, clinical, and community databases [10]. In addition, harmonized measures could also expand research opportunities for comparative effectiveness research, rapid learning systems/networks and large pragmatic trials [49,49,76].

9.2. *Portable measures*

Another potentially rich source of data and information is the patient health record which expands the EHR to make it more patient-centered by not only allowing patients to view their health records but provides information to patients that they can easily understand, renders clinical advice (e.g., calling attention to need to reduce cholesterol) and helps patients take action [77]. Personal health records can be personalized and tailored to assist with self-management, order and schedule appointments and medications, and provide secure patient–provider follow-up as well as increase patient-centered clinical encounters by communicating information from patient portals back to health care teams [77]. Furthermore, personal health records can provide a platform for rapid development and assessment of potential eHealth interventions. Finally, there has been a virtual explosion of mobile health applications which are collecting large amount of health data [78]; and these applications can be especially helpful for facilitating real world, ongoing self-monitoring. There are presently over 23,000 medical applications, but very few have been developed or testing using IS methods or models described here.

10. Discussion and recommendations

In summary, IS provides models and frameworks to focus attention on key translation issues, methods and designs to help make eHealth research more rapid and relevant. It also has implications for the development and use of practical measures and outcomes that can iteratively inform eHealth development, help with transparent reporting, and direct attention to key issues related to integration of research into policy and practice. Some examples of eHealth studies which have successfully used IS methods include Strecher and colleagues [3] use of a MOST design to determine what combination of intervention components and tailoring depth in a web-based smoking cessation programs produced the largest effects on 6 month smoking cessation and Glasgow and colleagues [46] use of RE-AIM to design and evaluate *Be Fit, Be Well*, a web or telephone-based weight and hypertension self-management intervention. These and other examples of eHealth studies that have addressed key IS issues discussed above are detailed in Table 2.

We are especially enthusiastic that IS can contribute methods to help make eHealth research a more integrated adaptive, rapid learning enterprise of value to consumers, health systems and community settings by providing frameworks and evaluation methods to address context. The Rapid and Relevant Research Paradigm described above is meant to stimulate thinking about ways to produce eHealth research that is both rigorous and relevant, but above all more rapid and more congruent with the pace of technology development.

One emerging opportunity for eHealth is the new frontier of “big data” [79]. Although bigger is not always better, today there is potential to integrate and link entire data ecosystems; not only concerning health characteristics and

Table 3 – Summary of how implementation science approaches can be used to enhance eHealth research.

Research phase	Implementation science recommendations
Study planning	• Be iterative • Learn on the fly • Fail rapidly • Involve users and stakeholder throughout
Study implementation	• Use adaptive and pragmatic designs • Learn rapidly • Maximize engagement • Use "MINC" principles[a] • Use standardized harmonized measures
Study reporting	• Greater transparency ○ Inclusions and exclusions at multiple levels—setting, staff, technology requirements and consumer selection ○ Report protocol changes ○ Include costs and resources required
Review and funding	• Needs to be more ○ Nimble ○ Flexible ○ Rapid ○ Contingent • Better integration of SBIR and Challenge Grants within research

[a] MINC: Minimal Intervention Needed for Change.

care utilization, but also on genomic and phenotypic data, patient reported measures, environmental exposures, geospatial databases, real time health behaviors [78]; and availability of community resources in ways never before possible. The opportunities are enormous, but the data must be brought together in ways that are meaningful to patients and actionable by practitioners so that this vast amount of information is turned into actionable knowledge, rather than just overwhelming surveillance data that overload individuals and data systems. IS can help advance big data initiatives by focusing efforts on the needs of patients and practice stakeholders [14,66].

Another critically important area in which IS can contribute to eHealth is through the provision of models and methods to systematically account for contextual factors (e.g., history and culture; collaborative nature of clinical work, organizational leadership, attitudes toward innovation, competing demands in daily clinical practice, policy and economic issues) that can moderate outcomes of eHealth interventions [13]. IS can also assist in designing eHealth programs that support, rather than interfere with clinical, administrative, and patient workflows.

A final area with great potential for future research is IS approaches that address health literacy and numeracy issues to create a health literate care system [33,80]. Disruptive innovations such as eHealth [83] present new opportunities but require a shift in methods; in where we look, perspectives taken; data reported, and also, potentially, how funding requests are reviewed. Table 3 summarizes how IS approaches can help to guide the planning and development of new eHealth research, iterative evaluation processes, transparent reporting of results, issues central to potential adopters, and finally, review of grants and publications. eHealth is a relatively young field and IS approaches should help to focus efforts in ways that they can be most effective, efficient, equitable, and help to rapidly move from intriguing ideas to products and services that improve public health.

Summary points

What was already known?

- That eHealth interventions are effective under some conditions.
- That implementation, long-term engagement, and retention of users in eHealth interventions is challenging.

What this paper adds:

- Systematic implementation science models, methods and measures for eHealth application.
- Examples of eHealth studies that demonstrate how research can be much more rapid and relevant to potential adopters.

Authors' contributions

All authors (a) wrote sections of the manuscript; (b) contributed key ideas; (c) reviewed, edited and approved the final submission.

Conflict of interest

The authors declare no conflict of interest.

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