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On-the-Go Adaptation of Implementation Approaches and Strategies in Health: Emerging Perspectives and Research Opportunities

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Abstract

In many cases, implementation approaches (composed of one or more strategies) may need to change over time to work optimally. We use a literature review to inform a mechanistic analysis of such on-the-go adaptations. We suggest that such adaptations of implementation strategies consist of three necessary steps. The first component is the initial effect of the implementation approach on intended implementation, service delivery, or clinical outcomes. Second, these initial effects must in turn be used to modify, alter, intensify, or otherwise change the implementation approach. Third, the modified approach itself has effects. Conceiving of adaptation as all three steps implies that a full understanding of adaptation involves (*a*) a sense of initial effects, (*b*) conceptualizing and documenting content and rationale for changes in approach (e.g., alteration, intensification), and (*c*) the effects of the changed approach (including how the latter effects depend on initial effects). Conceptualizing these steps can help researchers ask questions about adaptation (e.g., thresholds for change, dosing, potentiation, sequencing) to advance our understanding of implementation strategies.

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INTRODUCTION: ON-THE-GO ADAPTATION AND IMPLEMENTATION STRATEGIES

Many challenges for research on implementation strategies stem from a central tension: The units in which we seek behavior change—whether a population of patients, health care workers, organizations, or communities—often have both shared and distinctive features. The simultaneous presence of similarities and differences implies that effective implementation strategies (48, 49) [i.e., activities to promote the use of evidence-based interventions (EBIs) in these units] could be optimized with combined approaches that include those with broad effects (to address shared determinants) along with those with targeted effects (to address narrower determinants). Given the fact that implementation researchers increasingly believe that even with due diligence, many differences are difficult to anticipate at the onset of implementation activities, a combination of different implementation actions over time through acting, monitoring for response, and then modifying actions—perhaps iteratively—can potentially meet the needs of a group of units that respond differently. Understanding the dynamics that govern the effects of acting, monitoring, and changing implementation actions—or on-the-go adaptation—represents a promising area of inquiry for implementation science.

Adaptive implementation approaches where implementation activities are followed by monitoring for response and then modified hold a number of promising features. If we assume that not every unit (e.g., a clinic, health care worker, patient) in a group where we seek behavior change needs the same level of support to use an EBI, then applying strategies with a uniform intensity in all such units (e.g., clinic, provider, patient) may be wasteful (or frustrating) to those already doing well and may be insufficient for those that need more. In addition, many implementation strategies do not have large effects. As a result, multiple strategies or actions over time, with each change based on response, can help reach satisfactory outcomes in the entire target population (31). Combining actions, for example, that have broader effects across units, but perhaps weaker effects in each unit (such as cognitive nudges), with actions that have stronger effects in some units, even if usable only within a narrower group of nonresponders (e.g., coaching), could optimize both effectiveness and efficiency. Research on principles in adaptation will advance our understanding of implementation strategies (57).

The need to learn how to adapt links implementation science to other fields and creates opportunities from cross-disciplinary investigations. Methodological developments in statistics on dynamic treatment regimes (9), reinforcement learning, and other approaches (44) offer formal definition and estimation procedures for adaptative intervention effects. Adaptation has been an important focus of evolutionary biology, which has rich conceptual insights (e.g., adaptation versus maladaptation) that may be relevant for implementation science (46). Closer to home, continuous quality improvement and learning health systems are practices based on adaptations, where ongoing organizational learning (10) leads to tailoring, altering, or refining practice (30). Placing these improvement practices within a research topic will help answer important questions, such as knowing when we have enough information on response to commit to change and how to combine different changes (such as when to increase the intensity versus switch approaches altogether). The field of implementation science has called for a better understanding of how to fit interventions to settings through strategies: The dynamic sustainability framework (11), for example, calls attention to the need for interventions to continuously improve fit (14, 47, 58). Scientific attention to adaptation can help us make progress in this area.

In a discussion of research on adaptation of implementation strategies, it is worth acknowledging that adaptation is ubiquitous in health care and public health practice. Social workers, nurses,

doctors, and public health agencies working with patients or communities almost invariably take action, then assess effects, and then modify or change what they do based on the effects of those actions. Implementation strategies can be seen as formalized, standardized, and systematically described practice-based behaviors. Research on adaptation of implementation strategies, therefore, can be thought of as opportunity for "practice-based evidence" (28). Research on how actions change over time (14, 47) will be familiar to practitioners.

Further progress in research about adaptation of implementation strategies, however, must translate complex, practice-based behaviors into explicit, systematic, and measurable concepts. Many questions about adaptation of strategies require both further conceptual clarity and empirical research. Are changes that are responsive to initial effects categorically different from changes that are not? Can changes that create harm be considered adaptations, or should we use the concept of maladaptation (16) used in evolutionary biology? Furthermore, when changes to an implementation strategy do occur during use, can improved implementation co-occur with reduced effectiveness (perhaps when different user segments lead to different distal effects) and, if so, when? How can we avoid implementation efforts that inadvertently prioritize target populations with the most resources, greatest existing engagement in health services, and lowest risk (32)? Do certain adaptations (e.g., the introduction of an incentive for health care worker performance) create unintended future harms or constrain future choices (perhaps by crowding out intrinsic motivation), as hypothesized by some behavioral theories (27)? The answers to these questions will add to empirical evidence for implementation.

ADAPTATION IN IMPLEMENTATION RESEARCH: AN EVOLVING DISCOURSE

Adaptation has been the focus of a number of related discussions in implementation research, initially focused on how to change EBIs and now increasingly turning to implementation approaches, strategies, and actions.

Adaptation Versus Fidelity of Interventions

Adaptation of interventions that have been found efficacious in research settings for use in practice settings—particularly behavioral and mental health interventions—has been the focus of discussion and debate. In this debate, some have suggested that interventions that seem efficacious in trials lose effectiveness in practice settings because of poor fidelity to the actual interventions studied in research. Adaptation of those interventions has been invoked as a counterpoint to the fidelity. In this discussion, fidelity is often prioritized in research environments in part because it is misconstrued as requisite for consistency (which is needed for establishing causal effects), especially for nonbiological interventions (52). Fidelity to research interventions (particularly behavioral interventions), however, may be at odds with the flexibility required to actually carry out interventions in practice environments, thus rendering some efficacious interventions unimplementable (7). Some observers have decried changes made to interventions in practice environments and emphasized the need for fidelity (56). Others have called for researchers to study interventions and practices appropriate for implementation in the first place by being simpler or more changeable and adaptable. This desire for flexibility is reflected in the PRECIS-II criteria, which define criteria for pragmatic trials (39); flexibility of the intervention studied is one criterion for pragmatism. Of note, many clinical interventions, such as medications and devices, do not face similar issues with intervention fidelity because those are fixed and offered within a delivery system (e.g., prescription of medication) that is relatively highly controlled and regulated.

Adaptation to Improve the Fit of Interventions to New Settings Before Implementation

Given the need to change interventions to fit new settings, many papers provide process models that specify the steps needed to adapt interventions to new contexts. Escoffrey and colleagues (23) identified 13 adaptation frameworks, each with a number of steps such as (*a*) assess community, (*b*) understand the EBI(s), (*c*) select the EBI, (*d*) adapt the original EBI, and other steps. These changes were intended, for example, to shorten or simplify interventions (9). Relatedly, change aimed to fit cultural differences via the nature, language, and content has also been widely called for and used in the field of implementation research (4, 8, 34). These approaches are focused on evidence-based behavioral interventions and articulate a process that occurs at a single time point before entering into a new environment or context (11). These modifications address fit with practice environments and are focused on the usability and effects of adapted interventions.

Adaptation as a Driver of Sustained Implementation

The dynamic sustainability framework (DSF) introduced new directions in the conversation about adaptation (11). First, the DSF made change over time an explicit focus (which differs from an implication in some literature that adaptation is done at a single time point, when an intervention is transferred from one context to another), instead suggesting that adaptation is continuous and iterative. Second, DSF links with sustainability the process of multilevel fit of an intervention into a practice setting, and a practice setting into an ecological system. In the DSF, the constant longitudinal change is proposed as an antidote to two harmful constructs: that interventions lose effects in real-world settings (i.e., voltage drop) and that change is always harmful (i.e., drift). Instead, interventions should evolve over time to maintain fit (12). The DSF does not address how strategies can influence fit between interventions and settings over time, however.

Frameworks explicitly conceiving of implementation via causal pathways and mechanisms (38) include the model for adaptation design and impact (MADI) (35), which conceives of adaptation as a driver of implementation outcomes. This approach also categorizes changes as either systematic/unsystematic or proactive/reactive. Examples of unsystematic, reactive adaptations could include those made by a practitioner/provider improvising during delivery because of an unanticipated obstacle, but without consulting data/theory/stakeholders or considering the impact on outcomes. MADI provides a heuristic approach for practitioners considering adaptations. By invoking mediation, MADI comes close to using a causal framework but does not make use of causal language, concepts (e.g., counterfactuals), or tools (e.g., causal diagrams) (21) widely used to describe causal processes.

Documenting Adaptations to Help Us Understand Effects

Several innovations in implementation science also focus on the documentation of change in both interventions and strategies to help advance empirical research on change. Accordingly, frameworks and methods to guide the tracking of modifications to interventions (36) and implementation strategies (1, 5, 6, 42, 57, 61) have emerged. Emerging methods recommend recording changes that are made to interventions either in practice or in research settings, including who initiates the change, the reasons, and whether they are "fidelity concordant" or "discordant" (61). In addition, frameworks to track strategies and their evolution over time have been proposed, piloted, and reported (51). Changes, however, are included irrespective of whether those changes resulted from the effects of the strategy itself.

ON-THE-GO ADAPTATION OF IMPLEMENTATION STRATEGIES

Recent discussions of implementation and adaptation have not focused on adaptation and adaptivity of implementation strategies. While much discussion is going on about how to categorize implementation strategies, a needed area of investigation is to examine how strategies can best be tuned to response over time through adaptations. Many theories that describe both the determinants as well as the processes of implementation align well with the hypothesis that success requires different actions over time that depend on response. Cognitive, educational, or motivational theories that focus on individuals' thinking and decision-making generally suggest that behavioral is multi-mechanistic, wherein a sufficient cause for behavior change differs among people. One implication is that implementation approaches might best be guided by the rate, nature, and extent of the response to initial strategies. Likewise, theories of behavior change based on social processes (e.g., social learning) or organizational systems (e.g., organizational culture) suggest a range of determinants for change, which also suggests that actions will be most effective when based on target response.

A MECHANISTIC FRAMEWORK FOR ON-THE-GO ADAPTATION IN IMPLEMENTATION STRATEGIES

To extend discussion about adaptation in implementation science, we begin with proposing that adaptation in implementation approaches and strategies (26, 38) can be conceived of as four constituents: the parts, causes, arrangements, and regularity (15). We use a causal diagram (**Figure 1**) to represent this general structure for adaptations, which can be applied to adaptation of specific implementation approaches (21). First, we see adaptive implementation strategies as having immediate or short-term effects (Step 1). The level, nature, and types of effects on implementation, service delivery, or clinical outcomes in turn influence subsequent actions (Step 2). These changes

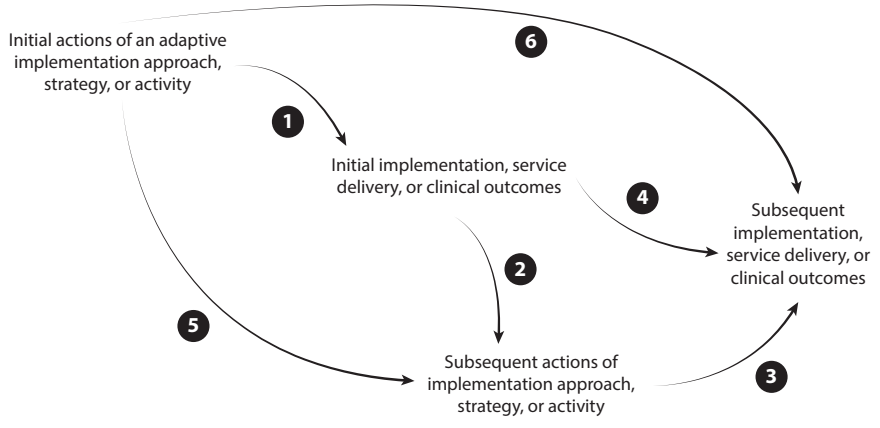

Figure 1

A diagram of adaptation in an implementation approach using one or more strategies or actions. Each step shows a potential causal effect. The diagram suggests that adaptation in a strategy consists of at least three components: (❶) The initial effect of an implementation action; (❷) change in actions that are in response to initial effects; and (❸) the effects of the changed actions themselves. In an adaptive implementation approach, not all effects are necessarily due to adaptive components. Some changes can occur on a schedule or are unintentional and are therefore not in response to initial effects (❹). For example, initial actions may influence (e.g., constrain or enable) subsequent actions irrespective of response to those initial actions (❺). Initial actions may also affect final outcomes directly (❻).

could be, for example, changing the dose of the action, switching to different actions, adding supplemental activities, and many others. The modified implementation actions then also affect further outcomes of interest (Step 3). In addition to these steps, it is also possible for a set of initial implementation actions to have an effect on final responses independent of the changes incurred (Step 4). For example, if the initial strategy is very effective, then much of the final outcome is already determined before any subsequent changes. Finally, the initial actions may also affect subsequent actions outside of the response to its effects; that is, effects of adapted actions can be constrained (or enabled) by the initial actions (Step 5). The initial actions may also affect final outcomes even without any sensing or responding (Step 6).

In this representation (**Figure 1**), Steps 1, 2, and 3 are all needed for adaptation to have occurred, and this carries several implications. First, examination of the adapted actions alone is therefore not a study of adaptation because adapted approaches, strategies, or actions are already a product of reacting or responding to initial effects. In other words, a scientific examination of the adapted implementation strategy is incomplete without an examination of the initial strategy, the change process, and the effects of the changed approach. Second, inclusion of Steps 1 through 3 also implies that the effects of adapted strategies are constrained (or enabled) by the initial approach. Different types of initial implementation activities may contain inherently greater or fewer possibilities for subsequent change. Myriad examples exist in implementing settings: Incentives directed at health care worker performance may act on extrinsic motivation, which could crowd out intrinsic motivation, thus limiting the effects of future nonincentive strategies (24, 54). This concept is well described in other fields. For example, in evolutionary biology the options available to a species in the face of change are constrained by prior evolutionary steps: Prehistoric plant species that evolved large seeds adapted to distribution by large terrestrial land mammals became extinct when large-mammal populations fell (16). A mechanism for adaptation that includes Steps 1 through 3 also underscores the critical importance of the concept of sensing response to initial actions in an adaptative implementation process (Step 2). The concept of basing one's approach to implementation on response is used in many approaches such as plan-do-study-act cycles (3), as well as audit and feedback, and could be a part of facilitation. Of note, this conceptualization does not say how formal or informal or how rigorous or precise information on response needs to be, which we see as an empirical question.

Additional pathways in this diagram (**Figure 1**) are not requisite for adaptation but nevertheless deserve attention because they act along with (and can be seen as one form of context for) the effects of adaptation. Initial outcomes may influence later outcomes independent of changes in the strategy (Step 4). In other cases, implementation activities could change but do so without sensing or responding to initial changes (Step 5). This action is, in and of itself, not an adaptation. For example, a strategy may seek to escalate intensity on a prespecified schedule. In addition, some initial actions may have fixed effects on final outcomes (Step 6). For example, health care workers targeted by a behavior change activity may be so put off by the initial strategy that no subsequent changes will have effects, perhaps through refusal to participate further. A study testing the effects of knowledge brokers, for example, found that in reality the brokers met with managers far less than intended, and qualitative work suggested that some managers refused further contact after the initial visit because they did not accept the premise that they needed the brokered knowledge (26).

Of note, some implementation strategies could change over time due to anticipated response, but not through sensing initial effects, which in this framework are not adaptive per se. In clinical medicine, antidepressants are titrated up based on a standard schedule to avoid excessive side effects based on schedules used in trials but not always as a response to individual patients. Glucocorticoid treatment is often tapered down after symptom cessation to avoid rebound effects and can be further tailored to response (25). For some strategies, such as practice facilitation, the work

changes over time by nature, some of which is dictated by the initial response but some of which is a consequence of the initial approach.

FIT OF A MECHANISTIC FRAMEWORK WITH THEORIES AND FRAMEWORKS IN IMPLEMENTATION

A multistep conceptualization of adaptation for implementation strategies presented in this article (**Figure 1**) offers a number of intersections with prevailing theories and frameworks about implementation. Normalization process theory (NPT) (41), for example, proposes four generative mechanisms (coherence, cognitive participation, collective action, and reflexive monitoring) that underlie the implementation (41). Even though they are in dialogue with each other, these generative mechanisms also contain a temporal sequence. Coherence, for example, precedes cognitive participation even though they mutually reinforce each other. Collective action has to precede reflexive monitoring: There is nothing to monitor if no actions have been taken. The different stages in implementation imply that an effective approach to implementation where levels of progress differ might best be based on strategies that target different stages as progress is made. An adaptive approach might, for example, hypothesize that actions should begin with targeting coherence around an implementation objective followed by focusing on cognitive participation and facilitating collective action, where transition depends on unit-level progress.

Adaptive conceptualizations of implementation strategies also fit well with Wensing's (59) description of "phases of change" during the use of implementation strategies. In this framing, implementation occurs through phases of orientation, insight, acceptance, change, and maintenance. Using this sequence, empirical research testing a sequence of strategies over time to address each of these levels of change could be promising. If in a population of units (whether patients, health care workers, or organizations), each sits at different phases from orientation to maintenance, then initial strategies targeting one phase (e.g., information) might need to be followed with another (e.g., change resources) to get all units to respond. Some of these phases may be obvious, but in reality, the boundary between a facility in need of more orientation versus insight may not be obvious.

Diffusion of innovations theory (19) continues to influence many of the current constructs in implementation science (for example, it can be seen in the consolidated framework for implementation research domains) (17). One key tenet of diffusion of innovations theory is that adoption of new technologies happens in a social system that can be segmented into innovators, early adopters, early majority, late majority, and laggards according to how readily individuals take up an innovation. Innovators and early adopters, for example, are likely to experiment with a new innovation after hearing about it passively or on mass media. The late majority, on the other hand, may depend on social proof—copying actions of others when making decisions under uncertainty—before deciding to take it up (13). When it is not easy to tell who is an early adopter and who is a late adopter, adaptive strategies that first influence innovators and early adopters followed by approaches directed toward late users would comport with diffusion of innovation theory.

While we raise two examples here, many frameworks about implementation segment suggest that the process of implementation can be understood through a sequence of stages. For example, the exploration preparation implementation and sustainment framework suggests that formative strategies (to explore and prepare) precede actions to implement and then to sustain (43). Other frameworks suggest broad determinants of behavior change, for example, suggesting that multicomponent approaches to behavior change should include predisposing, enabling, and reinforcing constructs (18, 29). These constructs could lend themselves to phased approaches in the sense

that enabling factors (things to make the desired behavior easier to do) depend on predisposing activities (things that help actors seek to carry out desired behaviors). Strategies might start with predisposing and then add enabling activities for those who are not adopting.

INSIGHTS FROM A MECHANISTIC EXAMINATION OF IMPLEMENTATION APPROACHES

Although the framework (**Figure 1**) consists of a small number of hypothesized causal relationships, it suggests a range of empirical scientific questions for implementation science.

Figure 1 suggests that context for implementation strategies is defined as those factors or features of an environment that influence the effects of the strategy (including those that work through adaptive mechanisms). That is to say, in this conceptualization, the things about context for a given approach are not all the things about the environment [e.g., those spelled out in the taxonomy of contexts (45)] but rather factors that influence response (Step 1) as well as the effect of the changed approach (Step 3). A general representation of adaptation in implementation approaches also enables calling out elements of context that affect particular steps in adaptation, thus improving our understanding of how particular adaptations are likely to generalize to other contexts. A mechanistic representation of adaptation will allow us to ask what specific elements of context matter for which adaptations and how.

The mechanistic representation also surfaces causal questions that could be asked, which are elaborated on in statistical literature on dynamic treatment regimes. Are strategies that are adaptive better than those that are not? In theory, there is good reason to believe that adaptivity would improve both the effectiveness and the efficiency of implementation strategies. Escalating only in those not initially responding enhances effects compared to the initial approach only, while waiting to escalate in those who need more enhances efficiency. Reasons why adaptation may not be worthwhile also exist. Adaptation implies both monitoring and reacting to response, and in many settings these activities are not trivial. Mass media campaigns to promote the use of an EBI, for example, prioritize scale and are rarely accompanied by concerted efforts to monitor the effects of those messages. Whether implementation approaches that are based on adjusting to response are better than those that are not is a worthy topic of empirical research in implementation science. Asking about the effects of adaptations is similar to the description of valences in adaptations as "positive (aligned with the goals and theory); neutral (neither aligned with nor deviated from the goals and theory); or negative (deviated from goals and theory)" (35); however, it places effects more centrally.

TYPES OF SCIENTIFIC QUESTIONS ABOUT ADAPTATIONS IN IMPLEMENTATION STRATEGIES

What kinds of adaptations work for implementation strategies, and how do they compare with each other? Even if adaptations are believed to be beneficial, myriad questions around how to adapt remain. A mechanistic understanding of the components helps identify questions that could be asked.

Dose

One class of questions about adaptations and implementation strategies addresses dose, or how intense the implementation activities are in terms of frequency, effort, resources, or other measures. In education, when students are not meeting performance targets, intensification of dose, for example, is composed of increasing the length of educational sessions, increasing the number

of intervention sessions per week, decreasing the group size, and increasing the total number of sessions. Heavier doses often have greater effects but cost more or require more time. Unnecessarily intensive efforts might also provoke resistance. For a simplified example drawing from an approach often discussed in implementation science, consider if a practice facilitator starts with visits to a practice one, two, or four days a month. Going once a month may be insufficient for most facilities; however, on the other hand, four times a month might be too costly and annoy the hosts. Is the right strategy to start with one session and then escalate to four for the nonresponders? Alternatively, we could start with two and then escalate to four in nonresponders (while maintaining two in those responding). Each represents an adaptive strategy, which can be examined comparatively and empirically. The optimal dosing schedule will depend on the question, the target settings, and the problem, but viewing the dose as a question about adaptation can produce general principles that accommodate site-to-site differences. For example, empirical research about adaptation of facilitation could find that the right dose is monthly visits until a readiness-to-change scale indicates high receptivity to change, after which dosing could increase to once weekly.

A variation on the question of dose is whether dosing should follow an escalation schedule in nonresponders or a de-escalation strategy in responders. In clinical medicine (outside of implementation and public health research), standard practices with medications often start with the lowest possible dose and then escalate in people who are not responding (e.g., antidepressant dosing, anticoagulation medications). The reasoning is often that the lowest possible dose is the best when it is sufficient, given some inherent risk of side effects as doses increase. On the other hand, there are instances where stronger immediate effects are needed to prevent further deterioration. Treating anticoagulation with heparin (a common blood-thinning medication) in someone with deep vein thrombosis (i.e., blood clot), for example, starts with a dose calculated to exceed the necessary threshold for most people, and then the dose is titrated down to ensure immediate effectiveness when time is of the essence (33). Using the practice facilitation example, one adaptive approach could be to start with four sessions a month and then reduce to one for those doing well. An alternative adaptive approach would be a strategy that starts with one session and then increases to four a month in facilities not doing well. These kinds of empirical comparisons are needed in implementation research.

Nature or Mechanism of Strategy

An alternative class of questions about the adaptation of implementation approaches revolves around the issue of complementary mechanisms of action. If we assume that different units (whether health care workers or patients or organizations) have different sufficient causes for change, then it may be that different implementation strategies, offered sequentially, would address different segments of the target population. If the determinants of sufficient causes of change in each unit are difficult to know ahead of time, an adaptive approach could be useful. Consider a simplified example of a population of health care workers where 50% of individuals lack only capability, 25% lack only motivation, 25% lack both, while 0% lack neither. If a skill-building workshop (that addresses capability successfully) is the same cost as an incentive (that addresses motivation), then starting with skill building delivered to all followed by an incentive for those not performing would be less expensive than a motivational approach delivered to all, followed by a skill-building strategy in nonresponders. Since these fractions of responders to each approach are not known at the onset, empirical research testing one strategy against another is needed to advance scientific knowledge about implementation strategies.

Thresholds

The thresholds for change in sequenced approaches to implementation represent an important class of empirical questions for implementation science. For an approach that involves escalation of those not responding well (whether this is for facilitation, training, or pay-for-performance), a threshold that is too high means that some who could benefit do not receive intensified activities (compromising overall effectiveness). Conversely, escalating prematurely means that some units that could succeed with less end up with more (compromising efficiency or cost-effectiveness). The right threshold for change in strategies could be tested with different adaptations.

In audit and feedback for restricting the use of antibiotics for upper airway respiratory tract infections, for example, a first round could be conducted with all health care workers at a facility and a second round conducted only with those who continue to prescribe inappropriately at a particular frequency. Since inappropriate prescribing is likely a continuous outcome, selecting a low threshold of inappropriate prescribing to trigger a second session of audit and feedback might not be worth the cost (since most of the reduction was taken in the first round). A high threshold might incur missed opportunities to reduce prescribing. The right threshold, however, is likely best determined with empirical studies.

Interaction (Priming and Desensitization)

In a sequenced bundle of implementation strategies, an implementation activity could influence the effects of another implementation action that is later in time but targets the same person or clinic through phenomena such as priming or desensitization. In other words, if strategies operate through stages, the initial stage may influence the success of later stages, even if the initial attempts fail to produce behavior change. For example, if implementation approaches such as practice facilitation or knowledge brokering rely on rapport formation as an important prerequisite for subsequent actions, then more successful rapport can magnify the potential effects of subsequent knowledge transfer or skill-building activities. Such effects are described in the psychology literature as potentiation or priming and are promising areas of investigation for implementation strategies.

While relatively few empirical studies have addressed effects of sequenced actions, in a 2019 study (40) investigators sought to potentiate the effects of training on the use of evidence-based mental health interventions through first acting on determinants of behavior change posited by the theory of planned behavior (i.e., attitudes, subjective norms, and perceived behavioral control). The investigators delivered a pre-implementation strategy targeting attitudes, norms, and behavioral control using education, social influences, and motivational interviewing. While the trial found small changes in attitudes, norms, and behavioral control, these differences did not translate into greater utilization for evidence-based mental health practices.

Types of Questions about Adaptation

Different adaptations (composed of initial action, response to effects, and subsequent actions) create different types of approaches ultimately with different potential effects that can be compared empirically. A widely used approach in global HIV public health antiretroviral treatment (an EBI) is to offer facility-based care for all and then move patients who are doing well (and making all their visits) into one of many emerging community-based treatment models (53). While this model of "deintensify[ing] among those doing well on facility-based care" could decongest clinics and improve efficiencies, an alternative point of view is that patients not doing well with initial facility-based care are unable to make visits because of demands to go to the facility. An alternative adaptive approach (**Figure 2**) would start with facility-based care, but then move patients not doing well into community-based treatment. Even though these strategies

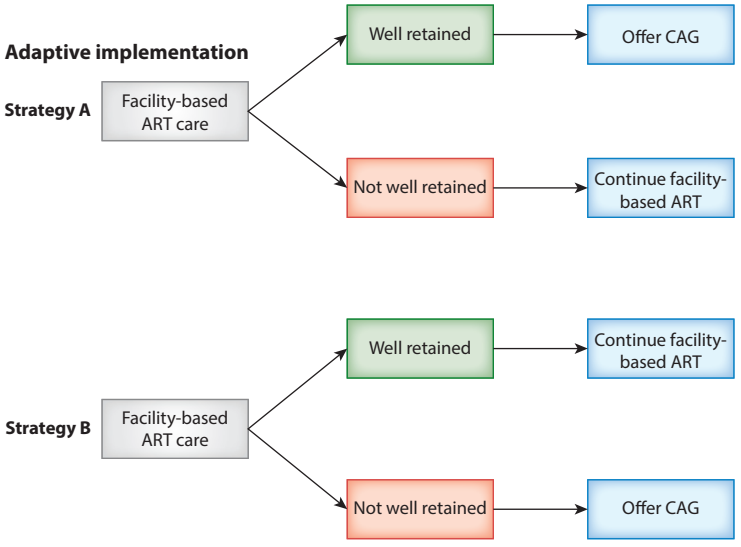

Figure 2

Two adaptive approaches or strategies for providing antiretroviral therapy (ART)—an evidence-based intervention—in global public health HIV programs. In adaptive strategy A, patients who adhere to appointments (i.e., and are therefore deemed well retained in care) are offered community-based care through a community adherence group (CAG) (20). Strategy B presents a different approach: Among those starting in facility-based care, those not well retained are offered a community-based option. By reducing long-term opportunity costs for patients doing well, strategy A seeks to sustain success. By reducing opportunity costs for those not responding to standard approaches, strategy B seeks to reach the unengaged. Different adaptive strategies can be empirically compared to each other to answer questions about efficiency and effectiveness of implementation approaches or strategies.

are composed of the same components, different combinations of them ultimately lead to quite distinct strategies for implementation, which can be compared in empirical scientific studies.

Adaptive Implementation Approaches and Their Effects

Adaptations may have layered effects on both use of an EBI and the effects of that EBI in the user segment that warrant empirical scientific attention as well. While implementation science has assumed that EBIs have uniform effects when used, there are reasons that this may not be the case; therefore, empirical and experimental examination of the relationship between uptake and effects in the units using the EBI is an important scientific agenda. For example, compare a pay-for-performance approach to a facilitation approach to increase the use of mental health depression screening and management. If driven purely by higher numbers, a pay-for-performance approach could result in screening 25% of patients but among a segment of the least severely depressed (who are more likely to make their clinical appointments and are least likely to have other severe issues that warrant prioritization). On the other hand, a facilitation approach might lead providers to focus screening on the 25% most at risk and who have the most intense depression. Even though the same fraction is screened, the yield could differ, and the response to therapy may differ (**Table 1**).

Study Designs

Many qualitative and mixed-methods approaches are often used to understand an adaptive process (60). Clinical studies (outside of implementation research but with relevance to this discussion)

Table 1 Adaptations may change the use of an EBI but also downstream effects among users

Planned changes in implementation approach in reaction to initial effects	Effect on use of target EBI in practice environment	Effect on downstream outcomes (including clinical outcomes) among users	Type of change to implementation approach	Description
Yes	Increase	Improve	Adaptation	Practice facilitation increases the use of colorectal cancer screening, and more cases of cancer are detected.
Yes	Increase	Worsen	Dilution	An incentive schema increases linkage to care after a positive HIV test, but sites then link patients with the facility where they tested (increasing linkage %) even if it is not where they intend to seek care, worsening retention among those linked.
Yes	Decrease	Improve	Targeting	Uptake was enhanced only among target units where effects are greatest; targeting may or may not improve overall effects.
Yes	Decrease	Worsen	Maladaptation	Changes failed to achieve better use of evidence-based interventions or directed such interventions to people who are not in need of the strategy or to people who are categorically not responsive to the approach.
No, changes are not intentional or are not in response to effects	Increase or decrease	Better or worse	Drift	Drift is unlikely to be helpful.

have examined the effects of adaptive approaches and have had widespread influence on clinical practice. For example, HIV treatment preserves immunological function but was thought to also incur a range of toxicities. A landmark randomized trial tested continuous HIV treatment against an adaptive approach in which treatment was started and stopped depending on the patient's CD4+ T cell levels (a marker of immunological function) to preserve immunological function at acceptable levels while minimizing cumulative drug exposure (22) (in this case, demonstrating continuous treatment to be superior to the adaptive approach). Sequential multiple assignment randomized trials are a class of novel designs that specifically compare different adaptations (2, 37). In such a study, units are randomized to an intervention, and nonresponders are rerandomized to alternative approaches. These designs have been widely applied to study behavioral and medical interventions and are now increasingly used for implementation strategies and approaches (50, 55).

CONCLUSIONS

A structured examination of adaptation in implementation strategies enables conceptual insights and directions for empirical research. Adaptation is ubiquitous in practice and is also highly nuanced. As a result, it is sometimes seen as art. Recent literature has brought adaptation into clearer scientific view through formalizing its components and via emerging study designs. Representing an adaptation for implementation strategies as a number of component steps in this review helps surface important empirical questions of relevance for implementation science. We must ask, for example, whether implementation strategies improve fit, acceptability, and appropriateness of interventions and whether the nature of those changes results in different effects of an EBI. A structured approach to adaptation of implementation strategies is unlikely to capture all the nuance associated with practice, but it can provide an entry into a range of empirical questions needed to advance the field.

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