

Fostering implementation of health services research findings into practice: A consolidated framework for advancing implementation science

Laura J. Damschroder, MS, MPH
David C. Aron, MD, MS
Rosalind E. Keith, MHSA
Susan R. Kirsh, MD
Jeffery A. Alexander, PhD
Julie C. Lowery, PhD

Contact: Laura J. Damschroder
Laura.Damschroder@va.gov

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Abstract

Background

There is increasing recognition that health services research must involve not only evaluation of health outcomes resulting from interventions but also evaluation of *implementation* processes. At least a dozen different models of implementation have been described in the literature. We sought a unified implementation framework to guide formative evaluations for implementations across various contexts. No such framework existed in the literature and thus we sought to fill this gap by developing the Consolidated Framework for Implementation Research (CFIR).

Methods

We searched the literature for models developed to contribute to the investigation of translation of research findings into practice. Articles were evaluated to identify constructs based on strength of conceptual or empirical support for influence on implementation, consistency in definitions, alignment with our own findings, and potential for measurement. Our search was not intended to be exhaustive – a “theme saturation” approach was used: when new articles failed to introduce constructs not already captured in our emerging framework, we stopped. We combined constructs across models from the literature that had different labels but were redundant or overlapping in definition and we parsed apart constructs that conflated underlying concepts.

Results

The CFIR reflects a parsimonious structure that recognizes the significant, complex, and interacting influence of: 1) intervention characteristics; 2) context (internal and external); and 3) the process by which implementation is accomplished. Eight constructs were identified related to the intervention (e.g., evidence strength and quality), four constructs

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were identified related to external context (e.g., patient needs and resources), 15 constructs were identified related to internal context (e.g., culture, leadership engagement), and four constructs were identified related to process (e.g., plan, evaluate and reflect). We present explicit definitions for each construct, describe how the CFIR can be used across all phases of implementation research, and provide a description illustrating how we used the CFIR.

Conclusion

The CFIR provides a pragmatic structure for approaching complex, interacting, and transient states of constructs in the real world by embracing, consolidating, and unifying key constructs from other models. It will help organize findings across disparate implementations, standardize constructs, and create a standard lexicon of terminology.

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To see far is one thing, going there is another Constantin Brancusi, 1876-1957

I. Background

While health services research may inform clinical and managerial practice, often it has not been translated into actual improvement. Examples abound of interventions proving successful in randomized trials but then fail or have troubling mixed effects in the “real world.” In fact, two-thirds of organizations’ efforts to implement change fail [1]. Barriers to implementation may arise at all levels of healthcare delivery: the patient level, the caregiving team or group level, the organizational level, and the market level [2]. There is increasing recognition that health services research must involve not only evaluation of summative end-point health outcomes from interventions but also evaluation and real-time adaptation of implementation processes [3] in order to maximize likelihood of successful implementation, prolong sustainability, and promote wider dissemination into practice. Researchers in the health services research domain have increasingly been focusing their efforts on this problem through research on the processes of implementation itself [4]. For example, the Quality Enhancement Research Initiative (QUERI), was established in VA in the US, to “enhance the quality and outcomes of VA health care by systematically implementing clinical research findings and evidence-based recommendations into routine clinical practice” [5, 6].

Though implementation research has made great strides, there are wide gaps in knowledge and understanding about the factors that make or break efforts to implement innovations in organizations. For example, the most common deficiency across studies is the failure to adequately include important contextual factors as active players in implementation efforts rather than as simply, a passive backdrop [7]. Change processes are highly contextually dependent and play out over time, during which context may change. Moreover, the choice of outcome indicator is complex [7]. Key to the conduct of research in this area, therefore, is the use of a comprehensive framework for identifying factors that

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influence successful implementation. At least a dozen models or frameworks with differing terminologies and varying degrees of theoretical and empirical support have been described in the literature for use in various healthcare contexts and at different ecological levels (e.g., individual change efforts, organizational or team change) [8].

As implementation researchers actively engaged in understanding implementation in organizations while simultaneously testing the effect of interventions, we sought a consolidated framework with a pragmatic design that would embrace, not replace, the vast knowledge already embedded in published frameworks and models related to implementation. Any such effort to “map” this complex terrain must negotiate the tension inherent in the level of detail to present; too much detail may lead to overly prescriptive approaches to implementation and fail to acknowledge fuzzy boundaries between concepts but too little detail leaves users stymied by lack of definition and coherence. Maps are problem solving tools that are supposed to help others navigate through reality [9]. It is the challenge of the cartographer to include relevant details and not the irrelevant ones. Models and frameworks provide a kind of map of the landscape for implementation. They are highly conceptual and thus challenging to use in the real world in a reliable and consistent way. Our challenge is in providing sufficient detail in a framework to guide successful implementation and sustainability, but not so much detail that it bogs evaluators down and becomes an impediment. We also wanted a framework that could be applied broadly across many different types of interventions and settings and that consolidates the considerable overlap in constructs across existing models and frameworks while also resolving the significant variations in definitions between them. A pragmatic and consolidated framework will help organize findings across disparate implementations, standardize constructs, and help to create a standard lexicon of terminology. No such framework exists in the literature and thus, we seek to fill this gap by developing the Consolidated Framework for Implementation Research (CFIR).

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In section II we describe our methods for selecting, combining, and eliminating constructs from models and frameworks described in the literature and present the consolidated set of constructs included in the CFIR. Section III describes steps for applying the CFIR in formative evaluations. Section IV describes four studies in which we have applied the CFIR, as example applications. Finally, Section V describes future directions for implementation in health services research.

II. Methods

We searched the literature for theories, models, and frameworks that have been proposed or used to understand or describe translation of research findings into practice. Articles were evaluated to identify constructs to include in the CFIR based on strength of conceptual or evidential support in the literature for influencing implementation, high consistency in definitions, alignment with our own experience, and potential for measurement. We focused primarily on meta-analyses or review articles using keyword searches and a snowball approach to identify new articles. Literature from a number of scientific disciplines was searched, including health services research, management theory, and clinical research. Our search was not intended to be exhaustive – a “theme saturation” approach was used: when new articles failed to introduce new concepts not already captured in our emerging framework, we stopped.

Our review of the literature revealed that many researchers use the terms “framework,” “model,” and “theory” interchangeably [10]. Kitson and colleagues recently sought to rectify this confusion in terminology by drawing on social policy research to put forth definitions for these terms in the health services research domain [11]. Separately, we explored definitions for these terms and our conclusions agreed with Kitson et al. Thus, we adopt their definitions here, providing a short synopsis to set the stage for the rest of this paper [11](page 10). A framework reflects

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"...professional consensus within a particular scientific community. It stands for the entire constellation of beliefs, values, and techniques shared by members of that community...[and] need not specify the direction of relationships or identify critical hypotheses."

A theory provides

"views on the causal relationships and seek to explain the phenomena, although from an interpretative perspective theories also play a vital role in offering explanations rather than causal relationships. Numerous theories may be consistent within the same framework."

Models

"represent a specific situation, are narrower in scope, and are more precise in their assumptions."

Our intent with the CFIR is to develop a framework: a way of organizing complex concepts that does not, at this stage, define interrelationships, specific hypotheses, or interactions. The CFIR provides a pragmatic organization of complex constructs upon which theories and models that hypothesize specific mechanisms of change and how they interact can be developed and tested empirically. For example, Gustafson's model for change was developed as a subjective Bayesian model to predict successful implementation in organizations [12] and provided empirical evidence for eight of the constructs included in the CFIR. Another study conducted a literature synthesis and mapped contextual factors that were found to be associated with research utilization by nurses onto the PARIHS framework [13].

III. Results & Discussion: The Consolidated Framework for Implementation Research

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Pettigrew and Whipp's seminal work [14] describes content of the innovation, context, and process as all having significant influence on implementing change. This parsimonious and intuitive 3-part structure is echoed by the PARIHS framework, a frequently used model to describe research uptake among nurses in healthcare delivery settings [11, 15, 16]. The PARIHS framework is built in the assumption that successful implementation is a function of evidence and context, based on which, facilitation strategies may be designed [11] to optimize research uptake. This framework hypothesizes that each of the three dimensions influence outcomes related to research uptake. The higher each dimension rates along several sub-scales, the higher the likelihood of research uptake [15]. The CFIR reflects this parsimonious structure but, like Pettigrew and Whipp [14], divides context into internal and external context to create a total of four specific domains: 1) intervention attributes; 2a) external context; 2b) internal context; and 3) process. The PARIHS framework was developed inductively while the CFIR was developed deductively from the literature to attempt to define, describe and understand the state of knowledge about how each construct influences implementation and set the stage for adding to this body of knowledge in a systematic way. The CFIR leans, perhaps, more toward a positivist orientation, compared to the PARIHS but we still put ourselves in the "realist" perspective that has its roots in sociology [17]. The CFIR's overarching structure sets up the essential questions encountered in any implementation study or evaluation: what contextual changes are being made (reflected in intervention attributes); why does the organization wish to change and why might the change be resisted or accepted (embodied in internal and external context); and how will the change be instituted over time (embodied in process) [18]? The last question points to another distinction between the PARIHS and the CFIR: facilitation in the PARIHS model may be only one element of the process in the CFIR. Facilitation strategies may or may not be a mechanism of change that connects the intervention and context to a successful implementation outcome.

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Figure 1 shows a visual representation of how these dimensions interact. The left side illustrates how, initially, fit may be poor between intervention and organizational context and then depicts the organization and the intervention co-evolving over time [19] to result in an ideal state of full assimilation of an intervention that can be sustained over time. The intervention is composed of a hard core, components that cannot be changed (e.g., an intervention introducing pharmacists into a primary care team to help manage blood pressure is not the same as one using case managers instead). In addition, there is a soft periphery comprised of the elements that can be tailored or adapted to particular contexts (e.g., providers may refer patients to the clinical pharmacist formally through the scheduling system or informally with phone call, depending on the organization). The process of implementation is often organic, going in fits and starts (far from linear), but ultimately these efforts will, hopefully, converge in a successful implementation. The CFIR can be used to plan or describe an organic process such as the one depicted or to plan a more linear process. The figure depicts fuzzy boundaries between internal and external contexts. This is in recognition that precise boundaries may change across scenarios and may change over time. For example, outlying clinics may be considered as part of the external context in one study but an integral part of internal context in another study.

To date, Greenhalgh and colleagues' conceptual model [20] is the most comprehensive description of disseminationⁱ of innovations into organizations. Table 1 lists the models, systems, and taxonomies that were considered for inclusion into the CFIR. Greenhalgh, et al.'s conceptual model already incorporates foundational work done by Rogers [21], Van de Ven [22], Gustafson[12], and others who are not explicitly listed in the table. Table 1 lists generally more recent models that were not covered in Greenhalgh, et al. The rows list the constructs that are included in the CFIR. Some constructs have more support in the literature than others. A large body of evidence exists for the importance of attributes of

ⁱ They refer to their work as a summary of "diffusion" of innovations (page 581) but their model is called, "Conceptual Model for Considering the Determinants of Diffusion, Dissemination, and Implementation of Innovations in Health Service Delivery and Organization" (page 595)

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interventions and internal context, but the overarching *process* of implementation has been studied little. Table 2 lists a short definition for each construct and Appendix 1 provides theoretical and empirical support for each of the CFIR constructs, along with qualitative coding notes used in a recent study.

Our goal was to establish a comprehensive and unifying framework that included constructs with strong or moderate support from theory or empirical evidence and based on our own experience. The CFIR can be used as an organizing framework within which to continuously build knowledge as findings and hypothesized models are developed and incorporated over time. This is made possible by the breadth of the CFIR because it can be applied consistently across multiple phases, contexts, and types of implementation projects and studies.

A WORD ON THE DEPENDENT VARIABLE

As elucidated by Dopson and Fitzgerald, the issue of the outcome variable is complex [7]. Researchers have used a myriad of endpoint measures of interest including, diffusion, dissemination, and implementation of innovations [20], research uptake [15], research utilization [23], knowledge transfer [24], transformational change [25], transferring research into practice [26], and implementation effectiveness [27] [28] [29] [30] [31] . Teasing out similarity and differences between these concepts and exploring implications of different philosophical approaches is beyond the scope of this paper. We focus, here, on the concept of implementation effectiveness defined by Klein and Sorra, as the critical gateway that occurs between the time of an organizational decision to adopt a specific practice and the point at which routine use of that practice by receiving stakeholders is accomplished; it is the vehicle by which that practice is assimilated into an organization [27]. A practice is a set of interrelated work activities informed by a body of knowledge or expertise and repeatedly utilized by individuals of groups to achieve a specified goal [32]. The particular practice could range from the specific use of a medication to a laparoscopic surgical

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procedure to a change in care delivery based on the chronic care model [33]. During this transitional time, we want to see targeted stakeholders become increasingly skillful, consistent, and committed in their use of the intervention or practice. There are three general classes of success or failure: 1) widespread or unit/role-specific avoidance of the intervention (non-use); 2) meager and unenthusiastic use (compliant use); and/or 3) skilled, enthusiastic, and consistent use (committed use) [27]. Implementation effectiveness, though straight-forward in concept, is elusive to measure because implementation does not follow a linear or sequential path. The definition of “committed use” will depend on the particular implementation with respect to the intervention, context, and the process itself. Conceptually, use of the intervention or practice should conform to pre-specified goals or protocols that define what it means for an intervention to be effectively implemented. This is often referred to as “fidelity” [34]. To complicate matters, during some “effective” implementations, the nature of the practice that constitutes the intervention may change. This tailoring is characteristic of the rapid cycle testing described as part of several different organizational change models [35-40]. Thus, what fidelity actually looks like depends on the intervention and may vary across sites implementing the same intervention.

In addition to fidelity, the skill and enthusiasm of stakeholders using the intervention should be assessed. Skill relies on a high level of working knowledge of the intervention and on sufficient practice and training. Enthusiasm is an affective response to the intervention and is a positive antecedent for change. Individual behavior change theories can inform strategies to optimize each of these dimensions [8, 21, 41].

RATIONALE FOR CFIR STRUCTURE AND CONSTRUCTS

Using the four major domains as an initial organizing structure (i.e., intervention, external and internal context, and process), we include many constructs from Greenhalgh, et al. and the nine other more recent models listed in Table 1. We combined some

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constructs within and across frameworks that may have had different labels but were redundant or difficult to distinguish from one another and parsed apart constructs that conflated concepts.

The CFIR focuses on constructs related specifically to implementation and subsequent routinization.ⁱⁱ In doing so, we consolidated constructs under diffusion and dissemination, system antecedents for innovation, system readiness for innovation, and implementation and routinization from Greenhalgh et al.'s conceptual model. They describe evidence about influences on implementation as "particularly complex and relatively sparse..." (page 610) and admit that many of the factors covered in the other topics also apply to implementation [20]. Appendix 1 provides theoretical and empirical support for each of the constructs included in the CFIR. The remainder of this section gives a brief description of each of the four major domains and highlights a few areas in which the CFIR departs from Greenhalgh, et al.'s conceptual model.

Within the intervention domain, we consolidated several constructs described by Greenhalgh, et al. For example, they describe observability, saying that if benefits of an innovation are observable to stakeholders, they will adopt it more easily. This construct was incorporated into the relative advantage construct. Observability (or visibility) of benefits is tightly coupled with stakeholders' perception of relative advantage and it would be challenging to tease out separable measures for both in the real world. Thus, we consolidated the two factors, while acknowledging the role of both. Two constructs were added based on other models and our own experience: 1) design quality and packaging; and 2) cost of the innovation. Greenhalgh et al. acknowledge the role of cost-effectiveness and perception of costs within other domains but others have acknowledged the role of cost as a potential barrier [24, 27]. Likewise, design quality and packaging have been found to

ⁱⁱ A listing of our guiding definitions for innovation, adoption, intervention, and implementation is included in Appendix 2.

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influence implementation and is included in Grol and colleague's list of innovation characteristics in their synthesis of the literature [8].

As seen in Table 1, few of the models we reviewed incorporated constructs related to external context. However, the influence of these factors is clear when it does appear in the literature [20]. External context includes four constructs, one of which is not included in Greenhalgh et al.'s model: patient needs and recourses. We added this construct, nonetheless, because the ultimate aim of most implementations in the health services sector is to improve care for patients. Incomplete or inaccurate evaluation of customer (patient) needs can lead to implementation failure [12]. Greenhalgh et al. describe several ways in which informal interorganizational networks can influence implementation. We parsed these into cosmopolitanism and peer pressure. External boundary spanning is included under cosmopolitanism because it is related to the affect of connections outside the organization. We combined political directives into intentional spread strategies because sometimes the directive component is incorporated into collaborative or other spread strategies.

We significantly reorganized constructs for internal context compared to Greenhalgh et al.'s model. We describe internal context in terms of organizational culture, networks and communication, implementation climate, readiness for implementation, and stakeholder attributes.

The network and communications construct in the CFIR consolidates several domains from Greenhalgh, et al. including organizational structure, intraorganizational communication, and intraorganizational networks [20]. Little is known about the interplay between formal structure, informal networks, and effective communication. Thus, we consolidate these concepts into a single construct to give wide latitude for researchers to take deductive approaches to explore alternate theories such as social networking [42] or complexity [43, 44] theories or inductive approaches to explore the role of various factors.

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Greenhalgh, et al. does not include organizational culture in their conceptual model but three of the models in Table 1 [27, 30, 31], along with other empirical evidence [45], provide rationale for including this in the CFIR. Culture is not defined consistently in the literature [46] (see Appendix 1 for a more detailed discussion) and represents a true challenge in discerning the influence of culture on a particular implementation. We include it in the CFIR because, despite variation in use and definition, it is thought to have significant influence on implementation success across many studies.

We introduce the concept of implementation climate, that is adapted from Klein and Sorra's conceptual model [27] (also tested empirically) [47, 48]. It is important to recognize that organizations have a multiplicity of coexisting cultures and climates. Greenhalgh, et al. refers to "receptive context for change" and "absorptive capacity" which each include an amalgam of several factors. We parse these out separately, defining some as part of implementation climate and others as part of readiness for implementation. Implementation climate is a socially-constructed concept (i.e., a collective reflection of stakeholders' experience of culture [46] as it relates to a particular intervention). Implementation climate is independent of vertical and horizontal organization and interrelationships between them. Boundaries between units, teams, service lines, individual clinics (just to name a few examples) may be quite porous or impervious. Thus, the influence of various organizational levels and subunits may penetrate organizational boundaries at varying degrees and therefore the boundaries of local climate will vary from context to context. The constructs within the CFIR need to be tailored to fit each particular implementation context. Six sub-constructs contribute to implementation climate (as listed in Tables 1 and 2) including tension for change, compatibility, relative priority placed on the intervention, incentives and rewards, goals and feedback, and learning climate. In addition to compatibility, two other similar factors are described in Greenhalgh, et al.'s model: meaning and innovation-system fit. All of three of these terms have a common root definition of aligning with stakeholders' values and norms and then vary in the degree to which they incorporate: goals, skill mix,

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strategies, and perceived needs [20]. We consolidate these together under our definition of compatibility. Relative priority is a socially constructed term that is “employees’ shared perceptions of the importance of the innovation implementation within the organization [27].” This term is uniquely described in Klein and Sorra’s implementation effectiveness model.

Readiness for change is a construct with wide variation in definitions within the literature. A more detailed discussion is provided in Appendix 1. In the CFIR, readiness for change includes sub-constructs that are relatively tangible and immediate to a particular implementation. If climate is the local manifestation of atmosphere, readiness for change incorporates mechanisms thought to be necessary for implementing within that climate. Sub-constructs include leadership engagement, available resources, access to information and knowledge, and implementation leaders. The latter sub-construct acknowledges the important role of opinion leaders, champions, external change agents, and others. Greenhalgh, et al. list the importance of homophily, opinion leaders, harnessing the opinion leader’s influence, champions, boundary spanners, role of change agency, and external change agents. The CFIR acknowledges these roles but also recognizes that more research is needed on defining and differentiating these roles.

The last, and certainly not least, of the major constructs under internal context is related to stakeholder attributes. Many of the models in the literature do not include individual stakeholders explicitly. Greenhalgh, et al. and another recent review, however, do acknowledge the important role of individual characteristics on the success of implementation [49]. Much has been written about individual change theories and strategies. Grol, et al. list ten different theories describing stages of change for individuals (e.g., Roger’s innovation-diffusion theory) and nine bodies of theories about strategies to move people through those stages (e.g., social learning theories) [8]. The CFIR is agnostic to any particular theory of individual behavior change. However, two general classes of attributes are common across many models and theories: 1) knowledge and beliefs

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(cognitive and affective); and 2) self-efficacy. We also added a third construct, organizational citizenship that though it was not included in any of the models we considered, represents an untapped area of research in the health services domain; exploring the relationship between individuals and the organization within which they work and how that affects individual adoption of an intervention. We include this construct in the CFIR as an invitation to explore this and other similar constructs.

The single most difficult domain to define and measure in implementation research is process. Many theories abound in just *how* implementation (or change) should be enacted including theories of total quality management, integrated care, complexity theory, organizational learning, and others [8]. The CFIR is agnostic as to a particular body of theory. However, most have four components in common (sometimes only implicitly, however): planning, engaging stakeholders, execution, and evaluation and reflection. We have relatively broad definitions for each of these areas because the process of change, by its very nature, defies definition – it is like water running through your hands. We know it exists and is essential but it does not remain in one place long enough nor does it progress predictably enough for specific definition or prescription. The process of implementation may be quite organic, barely discernable, and yet be effective in instituting desired change while other change processes encompass the entire organization and have its own formal structure and plan and may or may not fail. The CFIR follows the assumption that regardless of where any particular implementation process lays on this continuum, success is most likely in the presence of these four constructs. Greenhalgh, et al. describes assessment of implications and formal dissemination programs which we consolidate under planning. Their support and advocacy factor is included under the CFIR's stakeholder engagement construct and the capacity to evaluate the innovation is included in our evaluation and reflection construct. The fourth component of process, executing (the plan) is, of course necessary. This construct includes pilot testing and incremental implementations. The four constructs together echo the four component of the PDSA cycle

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that is a part of the quality improvement paradigm [50]: Plan, Do (execute), Study (evaluate and reflect), and Act (adjust the plan and/or execute, as appropriate). We have added engagement as a highlighted part of a cyclical approach because of the importance of engaging key stakeholders strategically in the process. The four constructs, plan, engage, execute, along with evaluate and reflect are often done in an incremental or spiral approach to implementation – often with fits and starts with many iterations of complete and incomplete cycles to accomplish full assimilation (as depicted in Figure 1).

IV. Research Context for the CFIR

Our goal in developing the CFIR is to facilitate progress in implementation practice and research. In addition to a broad array of contexts and interventions, implementation research can involve many different study designs. All of them, even the “gold standard” randomized controlled trial require formative evaluation. We believe that the CFIR provides a structure to help accomplish these steps across all phases of implementation and across studies. By an increasingly methodical understanding of key influences, increasingly more tailored formative evaluations can set the stage for sustainability and spread of effective interventions.

The CFIR also allows researchers to incorporate “implementation science” into implementation studies and help to identify the important formative evaluation questions and the methods for addressing them. Table 3 describes a typology of formative research and evaluation using Stetler and colleagues’ terminology [51] and providing a condensed overview to show how the CFIR can contribute in different phases of research. Prior to implementation, the CFIR can serve as a planning tool or guide for implementation studies and for adaptation of interventions to a particular setting. During implementation, the CFIR supports action-oriented research by guiding assessment of implementation progress and continued adaptation of the intervention. Post-implementation, the CFIR provides a

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framework by which to interpret outcomes and prospects for dissemination in a more consistent and rigorous manner. Because the CFIR is “agnostic” about any particular theory of change, whether individual or organizational, the breadth and comprehensiveness of the framework support the ability to test different theories and models. Grol and colleagues published a systematic review of change theories – across many ecological levels; e.g., individuals, teams, organizations [8]. As a start, we have mapped the theories they identified to CFIR constructs in Table 2 to illustrate how theories can be used to develop models and hypothesize relationships within the CFIR framework.

V. Application of the CFIR

It is not feasible to include all of the CFIR constructs in every implementation study. The CFIR can be reduced in scope by exploring the applicability of each construct with lead researchers (evaluators) and key stakeholders at the receiving sites for the specific study at hand. Using the CFIR as a starting point, critical constructs most likely to affect successful implementation for the specific intervention interacting within a specific context, can be identified along with hypotheses about how they might manifest. The CFIR recognizes that conceptual models of both the innovation and local context may change over time. For example, in an implementation of shared medical appointments (SMAs) (group visits) for diabetes, it became apparent that descriptions of SMA interventions from the literature provided insufficient detail to guide implementation into actual clinical settings. Kirsh et al., describes how implementation of SMAs at one local site started with an intervention at the inception of implementation that co-evolved with the local context as the SMAs were implemented, integrated and became a routine part of the local environment, as depicted in concept, in Figure 1. Through the implementation process, it became apparent that while core aspects (the hard core) of the SMA remained the same, other aspects of the SMA (the soft periphery) and local context each adapted, to settle into a sustainable state [19].

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Theories of change may need to be identified and may determine which CFIR constructs are included and how they are included in a study. The scope and nature of the process that will be used should also be considered; for example, whether it is a formal process conducted by an external change agent or an observational study of a relatively organic process of change. The perspective of time, relative to the implementation under study, will also influence variables to include; whether a retrospective evaluation of uptake of an intervention or an action-oriented evaluation from which implementation is planned and adjusted real-time.

The analytic plan will be determined by the outcomes of interest and study design. The state of knowledge clearly does not support a purely quantitative modeling approach for implementation that will be valid across contexts and interventions. Estabrooks and colleagues attempted hierarchical modeling of research uptake based on the PARIHS framework [52-55]. Though this was a herculean undertaking, and notable for its comprehensiveness, the models described less than half the variance in research uptake (their dependent variable), some results were puzzling [56], and the sparseness of validated measures of independent and dependent variables was made clear [57]. Both the PARIHS and CFIR define three main domains (intervention (evidence), context (including internal and external), and process (facilitation)). However, the elegant exterior belies the enormous complexity underlying these three domains. In the CFIR, the three domains are actually comprised of between four (the CFIR lists four constructs for process) and 19 explicitly defined constructs (for external and internal context), many of which are complicated to model and measure in isolation, even without considering multi-level interactions with other constructs and through different layers of the organization and over time. However, a variety of mixed methods study designs and analytic methods can be used to triangulate between types and sources of data to strengthen validity of conclusions [58]. Data sources may consist of quantitative instruments, semi-structured interviews, site visits, observations, meeting minutes, notes from significant phone calls and other informal

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conversations, email communications, formal policies and procedures, and other documents. Qualitative methods are better able to embrace the complexity of contexts and interactions with intervention and process to strengthen internal validity. Quantitative measures can strengthen external validity and enable higher-level modeling approaches. The choice of study design and analytic approach will drive development of data collection protocols.

VI. Examples of Application

We have used the CFIR in four studies across several phases of the research process. Table 4 lists these studies and the phase of application. We offer a brief description of one study to demonstrate how the CFIR can be used as a pragmatic guide in formative evaluation.

In our example study (a pre-implementation macro diagnosis), we used the CFIR in its entirety to explore barriers and facilitators to implementing a centrally-mandated weight management program (aka *MOVE!*) that was centrally mandated in Veterans Health Administration (VHA) medical centers across the United States. Medical centers varied in uptake from reporting no *MOVE!* visits at all to reporting thousands of visits. We used the CFIR to develop an interview guide with which to conduct phone interviews with key stakeholders at five purposively sampled sites, chosen because they had either low or high uptake of the *MOVE!* program (the interview guide is available from the authors, upon request). We used a largely deductive, team consensus approach to qualitative coding, using the CFIR as a high-level codebook. Appendix 1 lists excerpts of qualitative coding notes with short samples along with exclusion and inclusion criteria for each construct. Through qualitative analysis, the team rated the importance of each construct in the site's uptake of the weight management program (strong, moderate, or weak) and the valence (positive or negative). One example finding was that though all sites were significantly under-resourced, the high uptake sites exhibited a strong implementation climate or were

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able to improve implementation climate to achieve a significant degree of successful implementation; for example, by actively engaging key leaders in to get dedicated staff for the *MOVE!* program. Future implementation studies are being designed based on findings from this study.

VII. Conclusions

The CFIR draws on knowledge gained through largely reductionist, linear, cause-and-effect science while, at the same time, acknowledging that these constructs reside within complex, dynamic, non-linear, far-from-equilibrium organizations [59]. We can anticipate that the framework will require modification as new knowledge is developed. No framework or model can prescribe a definite path (like medicine from a bottle) to guarantee successful implementation. Instead, we often end up relying on what seem to be intuitive decisions based on incomplete understanding. The CFIR provides a pragmatic structure for approaching complex, interacting, and transient states of constructs in the real world by embracing, consolidating, and unifying key constructs from other frameworks, theories, and models. It offers a means by which to organize new knowledge across many studies in many different contexts with many different interacting dynamics.

Thus, we propose the CFIR as a means by which to see far, and perhaps actually get there; “there” being an ever more rich understanding of the complexities of implementation and a more predictable means by which to avoid failure and ensure successful implementations.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

LJD and JCL conceived of the paper. LJD drafted the initial form and all revisions of this paper. All other authors (REK, DCA, SRK, JAA) made significant contributions to the conceptual framework and read and modified drafts. All authors read and approved the final manuscript.

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FIGURE 1: Interaction of CFIR Components in Implementation

Table 1: Models Considered in the CFIR

Footnote for Table 1:

† Strength and direction of evidence is primarily taken from Greenhalgh, et al.[20]. However, only valence is shown for design quality and packaging, cost, patient needs and resources, incentives and rewards, culture, relative priority, individual attitudes because the strength of evidence for these was not included in Greenhalgh, et al.

+ → positive influence on implementation effectiveness

- → negative influence on implementation effectiveness

D: Direct evidence, cited by Greenhalgh et al.

I: Indirect evidence cited by Greenhalgh et al.

Table 2: List of CFIR Constructs with Short Description and Mapping to Selected Theories

Footnote for Table 2:

1. The list of theories was adapted from Grol, et al. (2007) and is, by no means, exhaustive.

Table 3: Evaluation Typology and Application of the Framework

Table 4: Example Studies Mapped to Phases of Research that used the CFIR in Formative Evaluations

ADDITIONAL FILES PROVIDED WITH THIS

MANUSCRIPT:

Additional file 1: Detailed rationale for inclusion of CFIR constructs: CFIR Appendix 1.pdf, 271K <http://www.implementationscience.com/....pdf>

Additional file 2: Working Definition of Terms used: CFIR Appendix 2.pdf, 44K <http://www.implementationscience.com/....pdf>

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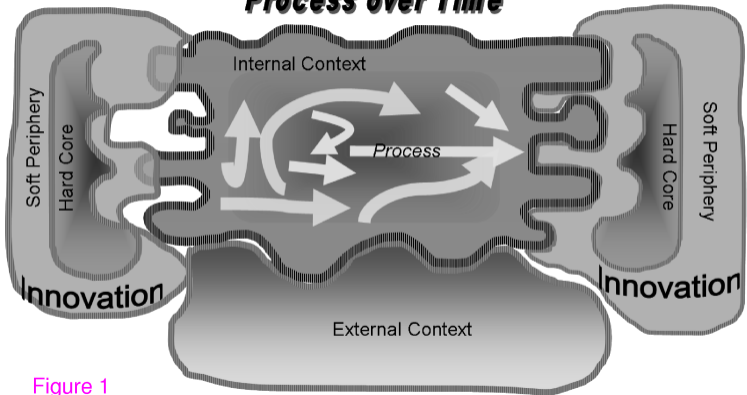


Figure 1

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