Topical Review: Theoretical Frameworks in Pediatric Adherence-Promotion Interventions: Research Findings and Methodological Implications

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Received October 6, 2014; revisions received February 23, 2015; accepted February 24, 2015

Abstract

Objective To summarize the guiding theoretical frameworks included in pediatric adherence-promotion interventions and characterize targeted domains using the theoretical domains framework (TDF), a standardized system developed by adult behavior change researchers. Methods A systematic review of PubMed, PsycINFO, and CINAHL databases identified 47 articles describing pediatric adherence-promotion interventions. Data extraction was completed independently by two authors. Targeted intervention domains were classified using the TDF. Results The majority of interventions did not cite a guiding theoretical framework or cited multiple theories with overlapping domains. The TDF was a reliable categorization system and suggested that pediatric adherence-promotion interventions most commonly target knowledge, skills, and social influences. Conclusions Pediatric adherence-promotion interventions draw from a variety of theories and lack a consistent language for describing targeted domains. The adapted TDF proposed here is one method of reducing variability in intervention development and reporting and may facilitate efforts to identify the processes that improve adherence.

Key words: adherence; chronic illness; research design and methods.

Nonadherence, or discordance between an individual’s behavior and medical advice, is a public health concern with significant patient-, family-, and health-care system-level implications (Modi et al., 2012). For youth with a chronic medical condition, nonadherence is a primary cause of treatment failure (Sabate, 2003) and is linked to decreased quality of life (Fredericks et al., 2008). In addition, nonadherence is associated with increased healthcare utilization (McGrady & Hommel, 2013) and may account for $100–$300 billion in US healthcare costs each year (Berg, Dischler, Wagner, Raia, & Palmer-Shevlin, 1993; DiMatteo, 2004).

The enormous public health impact of pediatric nonadherence highlights the critical need for effective interventions. Available pediatric adherence-promotion interventions, however, demonstrate heterogeneous and relatively small effect sizes (Graves, Roberts, Rapoff, & Boyer, 2010; Kahana, Drothar, & Frazier, 2008; Pai & McGrady, 2014). Moreover, while the iterative nature of intervention development should lead to increasing effect sizes, the observed
The magnitude of intervention effects has remained stagnant over the past 25 years. The small effect sizes demonstrated by available interventions may be owing, in part, to the incomplete understanding of which domains, or groups of theoretically related variables relevant to changing a health behavior, should be targeted to improve adherence. To date, research has primarily focused on comparing broad therapeutic approaches and established that behavioral and multicomponent interventions are more effective in improving adherence than educational interventions (Kahana et al., 2008). While this foundational work illustrates the importance of examining content as a driver of intervention effectiveness, it does not elucidate which domains (e.g., reinforcement, social support) account for intervention success. As it is likely that some domains are critical for intervention effectiveness, while others play a smaller role, failing to identify the relative importance of each domain prevents researchers from maximizing intervention effectiveness and efficiency.

The domains targeted in an intervention are often selected from a theoretical model (Prestwich et al., 2014). Identifying the theoretical model(s) that guide successful interventions, thus, could elucidate which domains account for intervention effectiveness. Implementation of this approach, however, has been hindered by the large number of competing theoretical models used to guide intervention development (Michie et al., 2005; Weinstein, 1993). Specifically, many theoretical models include shared as well as unique domains. As a result, it is often not possible to attribute differences in effect sizes across interventions to a single domain (Michie et al., 2005).

To overcome this barrier, health psychology theorists have developed the theoretical domains framework (TDF), a comprehensive system that synthesizes 33 behavior change theories and 128 key theoretical constructs into 12 domains (Cane, O’Connor, & Michie, 2012). The TDF was designed as an overarching framework to conceptualize health behavior change intervention content across numerous patient populations. According to the TDF, improvements in health behavior result from changes in one or more of 12 domains: skills, knowledge, behavioral regulation, reinforcement, optimism, intentions, goals, emotions, beliefs about consequences, beliefs about capabilities, environmental context and resources, and social influences (Cane et al., 2012; Cane, Richardson, Johnston, Ladha, & Michie, 2015). Based on the consensus of behavior change experts, each domain is classified under one of three components: capabilities, opportunities, or motivation (Figure 1, Cane et al., 2012). The TDF assumes that researchers will adapt the strategies used to target each domain to meet the specific needs of a given population. For example, targeting social influences for patients with type 2 diabetes may include involving significant others in treatment (Trief et al., 2011) while targeting social influences for patients with HIV may also include peer support to address HIV-related stigma (Katz et al., 2013).

The purpose of this review is to initiate a similar line of research in pediatric adherence-promotion and summarize the guiding theoretical models and targeted
domains included in current interventions. Similar to adult behavior change interventions, we hypothesize that pediatric adherence-promotion interventions will include multiple overlapping theoretical models. As a result, the second aim is to categorize intervention content using the TDF (Cane et al., 2012). The TDF is ideal for this purpose, as it assumes that researchers will modify strategies as appropriate for the target population and thus can be extended to assume that pediatric adherence-promotion researchers will modify content to be developmentally appropriate.

Assessing the Current State of the Literature

Method

PubMed, PsycINFO, and CINAHL databases were searched in August 2014 using medical subject headings to identify peer-reviewed manuscripts detailing pediatric (i.e., “child,” “chronic disease”) adherence-promotion (i.e., “patient compliance”) interventions (Supplementary Table S1). No restrictions were placed on publication date. Additional records were identified from previous reviews (Graves et al., 2010; Kahana et al., 2008; Pai & McGrady, 2014), resulting in 6,392 articles. One author applied the exclusion criteria to all articles and excluded 6,090 that did not include an adherence-promotion intervention or a pediatric sample. One author reviewed the full-text versions of the remaining 302 articles. Nonrandomized interventions with N < 10 in each arm (N = 118) and interventions that did not assess adherence to a prescribed medication regimen (i.e., blood glucose monitoring frequency; N = 108) were excluded. To include studies of adolescents and young adults but exclude those with adults only, interventions including participants with a mean age >18 years (N = 17) were excluded. Additional reasons for exclusion included articles describing a previously reported intervention (N = 8), articles not originally published in English (N = 2), and articles not describing intervention content (N = 2). To ensure accurate application of exclusion criteria, a second author reviewed a random 10% of the articles. Interrater agreement was 100%.

Forty-seven articles met inclusion criteria and were included in the review (Table I, Supplementary Table S2). Two authors extracted participant characteristics and intervention content using a standardized data collection form. Discrepancies were resolved via discussion, resulting in 100% agreement (κ = 1.00).

Results

Included interventions targeted children and adolescents with asthma (N = 21, 45%), type 1 or type 2 diabetes (N = 12, 26%), HIV (N = 4, 9%), juvenile arthritis (N = 2, 4%), latent tuberculosis infection (N = 1, 2%), cancer (N = 1, 2%), epilepsy (N = 1, 2%), sickle cell disease (N = 1, 2%), inflammatory bowel disease (N = 1, 2%), cystic fibrosis (N = 1, 2%), renal transplant (N = 1, 2%), or multiple chronic medical conditions (i.e., type 1 diabetes, autoimmune disease, kidney disease, asthma; N = 1, 2%). Interventions included an average of 142.51 participants (SD = 126.76, range = 29–603). Participants ranged in age from 3 months to 29 years. The majority of the interventions targeted both patients and caregivers (N = 33, 70%), while 23% (N = 11) targeted the patient only and 6% (N = 3) included caregivers only.

Fifty-one percent of studies did not report a guiding theoretical model (N = 24). Among studies describing theoretical model(s), the most commonly cited models included Social Cognitive Theory (N = 9, 19%), the Self-Regulation Model (N = 4, 9%), an Ecological Framework (N = 4, 9%), the Transtheoretical Model of Behavior Change (N = 3, 6%), Learning Theory (N = 3, 6%), Social Learning Theory (N = 2, 4%), Social Cognitive Learning Theory (N = 2, 4%), and the Health Belief Model (N = 2, 4%). The Chronic Care Model, Self-Determination Theory, Systems Theory, Applied Behavior Analytic Theory, and the Attitude, Social Influence, and Self-Efficacy Model were cited by one study each (2%). Seven studies (15%) cited more than one theoretical model.

Over half of the included studies reported at least one targeted domain (N = 25, 53%), with 13 interventions (28%) reporting more than one domain. The language used to describe domains varied across studies, even within those citing the same theoretical model. For example, Downs et al. (2006) report that their intervention guided by Social Cognitive Theory aimed to “increase caregiver self-management behaviors, increase child knowledge about airway clearance therapy and the children’s positive feelings about aerosol and airway clearance therapy regimens.” In contrast, Franklin et al. (2006) describe an intervention informed by Social Cognitive Theory that aimed to increase diabetes self-efficacy. This variation highlights the need for a standardized system for characterizing intervention content by domains.

Applying the TDF to Adherence-Promotion Interventions

Method

Two authors coded the domains targeted by each intervention according to previously published TDF definitions (Cane et al., 2012, 2015). Initial interrater reliability was good (κ = .63) but supported modifications to the TDF. Discussions between authors indicated that discrepancies resulted from incorrect classification of problem-solving and goal-setting. To
### Table I. Theoretical Domains and Corresponding Behavior Change Techniques in Reviewed Studies

<table>
<thead>
<tr>
<th>Theoretical domain (definition)</th>
<th>Number of studies N (%)</th>
<th>Sample behavior change techniques (definition)</th>
<th>Citations</th>
</tr>
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<tbody>
<tr>
<td>COM-B component: Capabilities</td>
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<tr>
<td><strong>Behavioral regulation</strong> (“Anything aimed at managing or changing objectively observed or measured actions”)</td>
<td>22 (47)</td>
<td>Prompt self-monitoring of behavior (asking the patient to keep a record of his or her adherence)</td>
<td>1, 2, 4, 5, 6, 11, 13, 15, 19, 22, 25, 27, 30, 32, 34, 36, 37, 38, 41, 43, 45, 46</td>
</tr>
<tr>
<td><strong>Knowledge</strong> (“An awareness of the existence of something”)</td>
<td>38 (81)</td>
<td>Provide information on health consequences (providing information on what will happen if the patient does not adhere to the regimen)</td>
<td>1, 2, 3, 4, 8, 10, 11, 12, 13, 14, 15, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 28, 29, 30, 31, 32, 33, 34, 36, 37, 39, 40, 41, 42, 44, 46, 47</td>
</tr>
<tr>
<td><strong>Skills</strong> (“An ability or proficiency acquired through practice”)</td>
<td>26 (55)</td>
<td>Provide instruction (teaching the patient how to take a medication) Teach problem-solving skills (teaching the patient how to use problem-solving skills to manage barriers to adherence)</td>
<td>2, 4, 5, 7, 11, 12, 13, 14, 19, 21, 25, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 41, 44, 45, 46, 47</td>
</tr>
<tr>
<td>COM-B component: Opportunities</td>
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<tr>
<td><strong>Environmental context and resources</strong> (“Any circumstance of a person’s situation or environment that discourages or encourages the development of skills and abilities, independence, social competence, and adaptive behavior”)</td>
<td>17 (36)</td>
<td>Restructuring the physical environment (teaching the patient to use materials and resources in his or her physical environment to facilitate adherence, e.g., setting a pill box out on the counter so it is visible)</td>
<td>5, 6, 7, 12, 13, 16, 19, 20, 26, 30, 31, 32, 34, 36, 38, 44, 47</td>
</tr>
<tr>
<td><strong>Social influences</strong> (“Those interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviors”)</td>
<td>27 (57)</td>
<td>Plan social support (helping the patient develop a plan for obtaining social support from relevant individuals including parents and peers) Social comparison (providing opportunities for the patient to compare his or her adherence with that of others)</td>
<td>3, 8, 11, 12, 13, 15, 16, 18, 19, 20, 23, 25, 26, 30, 31, 32, 33, 34, 35, 36, 39, 40, 41, 42, 44, 45, 46</td>
</tr>
<tr>
<td>COM-B component: Motivation</td>
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<tr>
<td><strong>Beliefs about capabilities</strong> (“Acceptance of the truth, reality, or validity about an ability, talent, or facility that a person can put to constructive use”)</td>
<td>4 (9)</td>
<td>Focus on past success (prompting the patient to provide self-motivating statements describing his or her past adherence behavior)</td>
<td>9, 31, 32, 36</td>
</tr>
<tr>
<td><strong>Beliefs about consequences</strong> (“Acceptance of the truth, reality, or validity about outcomes of a behavior in a given situation”)</td>
<td>10 (21)</td>
<td>Pros and cons (encouraging the patient to consider the pros and cons of adherence in relation to the goals, values, and priorities of the patient)</td>
<td>4, 9, 17, 19, 24, 31, 35, 36, 37, 42</td>
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<tr>
<td><strong>Emotion</strong> (“A complex reaction pattern, involving experiential, behavioral, and physiological elements, by which the individual attempts to deal with a personally significant matter or event”)</td>
<td>9 (19)</td>
<td>Reduce negative emotions (teaching specific coping strategies such as relaxation and deep breathing that target anxiety, stress, depressive symptoms, and other negative emotions that may impact adherence)</td>
<td>3, 13, 25, 30, 31, 33, 39, 41, 44</td>
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<td><strong>Goals</strong> (“Mental representations of outcomes or end states that an individual wants to achieve”)</td>
<td>12 (26)</td>
<td>Collaborative goal setting (teaching the patient to identify a goal, brainstorm potential solutions, select a solution to implement, and develop a plan for implementation)</td>
<td>9, 16, 17, 19, 20, 25, 26, 32, 34, 35, 36, 37</td>
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<tr>
<td><strong>Intentions</strong> (“A conscious decision to perform a behavior or a resolve to act in a certain way”)</td>
<td>4 (9)</td>
<td>Behavioral contract (developing and signing a contract specifying the behavior to be performed)</td>
<td>17, 26, 45, 46</td>
</tr>
<tr>
<td><strong>Optimism</strong> (“The confidence that things will happen for the best or that desired goals will be attained”)</td>
<td>1 (2)</td>
<td>Verbal persuasion to boost self-efficacy (providing general praise or rewards not contingent on a patient’s performance)</td>
<td>39</td>
</tr>
<tr>
<td><strong>Reinforcement</strong> (“Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus”)</td>
<td>16 (34)</td>
<td>Contingent rewards (Providing praise, encouragement, or material rewards that are explicitly linked to obtaining an adherence-related goal)</td>
<td>1, 2, 5, 6, 7, 11, 13, 15, 19, 20, 27, 32, 34, 36, 37, 38</td>
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</table>

*aFrom Cane et al. (2012). bDefinitions adapted from Abraham and Michie (2008). cStudies (details available in Supplemental Table 2): 1 = Berkovitch et al., 1998; 2 = Berrien et al., 2004; 3 = Bhana et al., 2014; 4 = Bonner et al., 2002; 5 = Burkhart et al., 2002; 6 = Burkhart et al., 2007; 7 = Butz et al., 2010; 8 = Chen et al., 2013; 9 = Christakis et al., 2012, 10 = Downs et al., 2006; 11 = Duncan et al., 2013; 12 = Ellis et al., 2005; 13 = Ellis et al., 2012; 14 = Farber & Oliveria 2004; 15 = Fennell et al., 1994; 16 = Franklin et al., 2006; 17 = Garburt et al., 2010; 18 = Hederos et al., 2005; 19 = Hommel et al., 2012; 20 = Howell et al., 2003; 21 = Howe et al., 2005; 22 = Jan et al., 2007; 23 = Joseph et al., 2007; 24 = Kato et al., 2008; 25 = Katz et al., 2013; 26 = Krieger et al., 2009; 27 = Kumar et al., 2004; 28 = Lawson et al., 2005; 29 = LeBaron et al., 1985; 30 = Letourneau et al., 2013; 31 = Lewis et al., 1984; 32 = McGhan et al., 2003; 33 = Mulvaney et al., 2010; 34 = Naar-King et al., 2013; 35 = Nansel et al., 2012; 36 = Nansel et al., 2007; 37 = Otsuki et al., 2009; 38 = Rapoff et al., 2002; 39 = Scholten et al., 2013; 40 = Shope, 1980; 41 = Stinson et al., 2010; 42 = van Es et al., 2001; 43 = Wamalwa et al., 2009; 44 = Wilson et al., 1996; 45 = Wysocki et al., 2000; 46 = Wysocki et al., 2006; 47 = Zivkovic et al., 2008. dCOM-B: Capabilities, Opportunities, Motivation Model of Behavior Change. eAdditions to Cane et al. (2012).
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improve agreement, two modifications were made to the TDF. First, problem-solving was added as a technique targeting the domain “skills.” Second, the technique “goal-setting” targeting the domain “goals” was revised to clarify that goal-setting reflects a collaborative process of teaching goal-setting, as opposed to a prescriptive process during which the medical team sets adherence goals without involving the patient and/or family. Two authors coded each intervention using the revised TDF. Interrater reliability was $\kappa = .87$ and all discrepancies were resolved via discussion.

**Results**

The most frequently targeted domains included knowledge ($N = 38, 81\%$), skills ($N = 26, 55\%$), social influences ($N = 27, 57\%$), behavioral regulation ($N = 22, 47\%$), environmental context and resources ($N = 17, 36\%$), and/or reinforcement ($N = 16, 34\%$). Exemplars of behavior change techniques for each domain are provided in Table I.

**Conclusions**

One potential method of advancing pediatric adherence-promotion intervention research is to shift from tailoring established interventions for new populations to tackling broader issues of theory testing and intervention optimization. Achieving this goal requires that pediatric adherence-promotion intervention research be driven by questions such as: *What are the fundamental domains driving effective pediatric adherence-promotion interventions?* Assuming interventions are developed to target the domains included in their guiding theoretical model, identifying the model(s) cited by successful interventions could indicate which domains drive effective interventions. However, this strategy may not be feasible for pediatric adherence-promotion intervention research as two-thirds of included studies did not cite a guiding theoretical model or cited multiple models. This suggests that available theoretical models may not always align with the needs of a given population or previous research. For example, if a researcher developing an intervention wishes to target both theoretically and empirically supported domains not accurately captured by a single model, the researcher can cite multiple models, no models, or propose a new model. Each may pose difficulties not only for researchers attempting to describe their intervention content, but also for readers attempting to draw conclusions about which domains were targeted by the intervention, and thus, should be addressed in future research or clinical care.

Alternatively, one innovative option is to select and assess (Taylor, Lawton, & Connor, 2013) intervention content that targets domains included in the TDF. Application of the TDF to pediatric adherence-promotion interventions included in this review suggests that interventions most commonly target the domains of knowledge, skills, and social influences. Future use of the standardized language afforded by the TDF to characterize targeted domains would enable researchers to test mechanisms of change and compare effects across interventions by testing questions such as: *Did increasing knowledge (e.g., via teaching medication knowledge), skills (e.g., via teaching problem-solving), or social influences (e.g., via planning caregiver support) account for the improvements in adherence evidenced in this trial?* This information could lead to shorter but equally effective interventions and is critical, as our health-care system becomes increasingly focused on delivering effective care while minimizing costs.

Despite its strengths, researchers using the TDF should consider several points to enhance its application to a pediatric population. Consistent with the TDF’s approach to disease-specific adjustments, developmentally appropriate modifications were conceptualized as an overarching consideration of study design rather than a separate domain. In light of the scarce research defining “developmentally appropriate” adaptations, dissemination and replication efforts may be enhanced if researchers using the TDF explicitly describe how strategies were modified to be developmentally appropriate (Pedlow & Carey, 2004). Second, the TDF does not differentiate between domains targeting the child and those targeting caregivers, peers, or others in the intervention. For the purposes of this study, intervention content delivered to other individuals was coded as targeting “social influences.” While beyond the scope of this study, the TDF may be refined further to account for the unique role of caregivers, peers, and other relevant individuals in an ecological network.

The relatively stagnant effect sizes demonstrated by pediatric adherence-promotion interventions highlight the need for an empirically supported research agenda. The TDF provides a reliable system for characterizing intervention domains. Application of the TDF has the potential to elucidate the processes that underlie intervention effectiveness, and as a result, the domains most likely to improve adherence if targeted.

**Supplementary Data**

Supplementary data can be found at: http://www.jpepsy.oxfordjournals.org/.

**Funding**

This work was supported by National Institutes of Health grant T32HD068223 to M.E.M. and J.L.R.

**Conflicts of interest:** None declared.

**References**


