Research Article

Community Intervention Model to Reduce Inappropriate Antibiotic Use

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ABSTRACT

Background: *The Inter-Mountain Project on Antibiotic Resistance and Therapy (IMPART) is an intervention that addresses emerging antimicrobial resistance and the reduction of unnecessary antimicrobial use.* ***Purpose:*** *This study assesses the design and implementation of the community intervention component of IMPART.* ***Methods:*** *The study was conducted in 12 rural Utah and Idaho communities. Following initial implementation, the intervention was evaluated and redesigned based on health behavior theory. Community penetration and intercept interview data were analyzed using multi-level logistic regression.* ***Results:*** *Over 10% of interview respondents were familiar with IMPART. Those exposed to intervention materials tended to be younger, female, and more likely to have had a family member with recent respiratory illness. Of those who had seen the project Self-Care Guide, 62% reported having a copy and 32% had talked to others about the information it contained. Correct responses to antibiotic knowledge questions were higher among those with high (OR=2.02) and low exposure (OR=1.27) to the intervention versus no exposure.* ***Discussion:*** *Theoretically-based community interventions such as IMPART can be used to promote appropriate, positively framed health behaviors.* ***Translation to Health Education Practice:*** *IMPART serves as an example of how health interventions can benefit from health behavior theory.*

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BACKGROUND

The selection pressure induced by heavy use of antimicrobial drugs has led to progressively increased levels of resistance among common bacterial pathogens. The consequence of resistance is diminished effectiveness of antimicrobial drugs when they are needed. Approximately 50% of courses of ambulatory antimicrobial drugs are prescribed for patients with viral respiratory infections and therefore are not clinically indicated, which is dually driven by patient demand, perceived or actual, and clinician practice.[1-7] Different types of interventions have been undertaken, in various settings,

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to reduce inappropriate antibiotic use.[8-21] Most interventions have adopted an educational approach that relies primarily on the delivery of information, with few explicitly developed utilizing theoretic frameworks based on behavior change models.[22-27]

Designing an intervention to change patient behavior with respect to antimicrobial usage exposes a central challenge. Although a variety of patient behaviors contribute to overuse of antimicrobial drugs, the final approval of an antimicrobial prescription is made by the clinician. Additionally, messages about appropriate antimicrobial use are often expressed as prohibitions; for instance, "do not take antibiotics for viral infections." From a behavior change perspective, casting these messages as positive statements may be advantageous. However, accomplishing this conversion in the domain of decreasing antimicrobial use presents a challenge.

PURPOSE

The purpose of this project was to design, implement, and conduct a formative evaluation[28] of a rural community intervention to reduce unnecessary antimicrobial use. The intervention focused on the patient, was explicitly tied to a multi-theoretic framework of behavior change, and was positively framed.[29] Two specific sets of patient behaviors were targeted: self-management of common respiratory infections and communication with the healthcare provider.

METHODS

Study Communities

The community intervention was implemented in conjunction with a twelve community-randomized trial conducted in Utah and Idaho called the Inter-Mountain Project on Antibiotic Resistance and Therapy (IMPART).[30] Each participating community had a hospital and a central population of less than 100,000. Participating communities were randomly selected from among those meeting these criteria within the boundaries of the two states and were randomly assigned to one of two groups: implementation of community intervention alone or community intervention plus clinical-based decision support. The results of the overall community randomized trial are described elsewhere.[31] The focus of this paper is on the community intervention, which was implemented similarly in all twelve communities.

Design and Implementation of the Community Intervention

Phase I: Community intervention roll-out

The community intervention began with a traditional educational approach to distribution of information about appropriate antimicrobial use. To get materials into community settings rapidly, brochures and posters available through the Centers for Disease Control and Prevention (CDC)[32] were adapted and disseminated throughout community sites, including health care, educational, retail and civic locations. Distribution was primarily passive, with materials available in clinic waiting rooms or pharmacy counters. Meetings with medical, civic and education leaders within each community were convened to introduce the project, present study related plans and seek guidance on engaging the respective community.

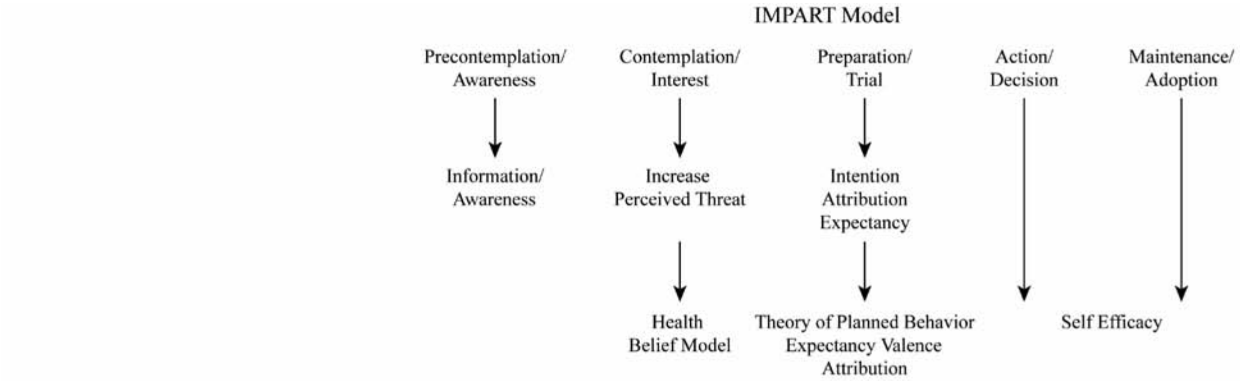
Phase II: Intervention redesign

At the mid-point of the first intervention year, we interrupted the intervention to evaluate its composition. We determined that a theoretical foundation was needed to unify current and future elements of the intervention. A redesign process followed this evaluation using a three-pronged strategy. First, we identified and prioritized the explicit patient behaviors that served as targets for change. The intervention team identified a series of behaviors that were deemed consistent with reducing antibiotic use. The two types of behaviors that received the highest emphasis were *self-management* of common respiratory infections and *communication* with the healthcare provider. Self-management behaviors encompassed care of self and of dependent children, including cues for seeking formal medical care. Communication behaviors were focused on modality and approach as well as specific types of information to seek. Recommended self-management and communication behaviors were framed in positive terms as *what to do* rather than *what NOT to do*. Our underlying premise was that a positively framed intervention promoted specific actions and was more likely to have long-term success than an intervention expressed in negative terms. The intervention also was redesigned to transition patient-controlled behaviors from those which directly contribute to overuse of antimicrobial drugs, such as stockpiling or sharing antimicrobial drugs, to behaviors that were consistent with appropriate antimicrobial use.

Second, we formulated a multi-theoretical model, hereafter referred to as the IMPART model,[30] which embedded behavior-change theories into the *Stages of Change* from the Transtheoretical Model (TTM)[29] (Figure 1). TTM posits that individuals reside in one of five distinctive stages relative to behavior change; precontemplation, contemplation, preparation, action, and maintenance. We considered provision of information most relevant to the precontemplation stage. The perception of risk, a concept drawn from the Health Belief Model,[33] was deemed most suited to the contemplation phase. Intention, from the Theory of Planned Behavior,[34] was mapped to the preparation stage along with Attribution and Expectancy-Valence.[35,36] Self-efficacy was felt to be most crucial for action and maintenance stages.[37] The Diffusion of Innovations stages were integrated across the TTM Stages of Change.[38]

Third, we used the IMPART model to classify the various components of the community intervention: initially as a retrospective assessment of first year community intervention activities, then to guide the development of proposed elements of the intervention and to prioritize them for second and third year implementation. Rating of activities was done through group consensus using a four-tiered ordinal score (minimal to high emphasis) for each stage. For example, passive distribution of brochures which provide information about antibiotics and antibiotic resistance was considered a type of intervention more heavily weighted toward the *precontemplation* stage—focusing

Figure 1. Multi-Theoretical IMPART Model



Assessment of Year 1 Interventions in Behavioral Context
(subjective assessment of initial roll-out community intervention activities)

	Precontemplation/ Awareness	Contemplation/ Interest	Preparation/ Trial	Action/ Decision	Maintenance/ Adoption
Brochures	****	*	*	**	*
Waiting Room Posters	***	**	*	*	*
Exam Room Posters		***	***		
Media Campaign	***				
Radio (AWARE)	***	*			*
Post Cards/Magnets	***			*	
Clinic Visits	***	**			
Day Care/Superintendent	**	*			
Mayor Visits					
Pharmacy Visits	**	*	*	*	

Assessment of Year 2 Interventions in Behavioral Context
(*redesigned* interventions with planned emphases)

	Precontemplation/ Awareness	Contemplation/ Interest	Preparation/ Trial	Action/ Decision	Maintenance/ Adoption
Community Speakers	***	**	**	**	****
Self-Care Guide	**	*	***	***	**
Media Campaign	**	***	***	**	*
Clinic/Staff Training	*	*	**	**	**
Web Page	***	**	**	*	
School-Based Activities	***	***		**	

*low emphasis, **moderately low emphasis, ***moderately high emphasis, ****high emphasis

on awareness raising—than toward the *action* stage.

This rating system was then used as a heuristic to prioritize further community intervention activities. Additional intervention activities were designed with specific attention to preparation, action and maintenance. The focus on the later stages of change also guided us to develop and implement more interactive interventions. We refocused the community intervention to directly promote targeted behaviors through active community engagement within existing community infrastructures.

Implementation of the Model-Based Intervention

The positive behaviors that were the focus of the redesigned intervention were framed as innovations that departed from typical behaviors. Intervention components are described below.

Self-Care Guide

The Self-Care Guide (SCG) was created as a printed resource to provide specific self-care instructions for management of acute respiratory infections. First, a list of common ailments for which antibiotics are often inappropriately given was created. Usual symptoms, causes and recommendations for when to contact a healthcare provider were compiled for each of these illnesses. Recommendations regarding prevention and self treatment of respiratory illnesses were developed by the physician members of the research team, using evidence-based guidelines when available.[10,31]

Basic recommendations to avoid promotion of antimicrobial resistance were also developed. Following the compilation of the initial draft version of the SCG, we sought input from potential users (including rural community citizens and primary healthcare providers). Adaptations were made to this guide with respect to such features as the spiral binding, type of paper and magnet strength for display on recipients' refrigerators along with alterations to format and content. The final version of the SCG was then disseminated throughout the study communities via medical clinics, health departments and other civic locations. SCG distribution was incorporated into other IMPART intervention activities such as interactive displays at community events (e.g., health fairs), community presentations and elementary school-based interventions.

Health Fairs and Other Community Events

Displays and activities focusing on promotion of the targeted behaviors were used at health fairs and other community events to provide community members with intervention materials and to actively promote appropriate use of antibiotics. To attract residents to participate in this intervention, a roulette wheel using the positive behavior focus was built. The wheel included multiple questions about appropriate antibiotic use. Community members were invited to review intervention materials and display information, then spin the wheel and respond to the designated question. Depending on the correctness of their responses, participants were rewarded with items such as cups, pens, or flying discs. All items included intervention messages as well as the address for the IMPART website.

Community Speakers' Bureau and Presentations

To work proactively with residents, a community speakers' bureau was developed. Presentations were made to a variety of groups through churches, schools, clubs and other associations. These presentations were based on the IMPART model and ranged from providing information about antimicrobial resistance to modeling the positive behaviors consistent with appropriate antibiotic use. The SCG was provided to participants, and its active use was incorporated into the presentation.

Newspaper Articles

A series of five news articles was written based on the *Stages of Change* focus areas in the IMPART model. Articles ranged from being informational (consistent with the focus of activities for those within the *precontemplation stage*) to promoting readers' efficacy to engage in the positive behaviors of self-managing common illnesses and communicating with the healthcare provider regarding appropriate treatment (emphasizing the *Action* and *Maintenance stages*). These articles were submitted to the local and regional newspapers across study sites for publication.

School-based Interventions

A school based intervention was also established. This intervention taught children about preventing illness, the role of antibiotics in treating illness and how to avoid antibiotic resistance. Following curriculum guidelines, this intervention was administered to children in the third grade. The intervention included a series of in-class activities, as well as homework that students were to complete with their parents. The SCG was provided to each child for use in their households, and homework activities focused on delivering intervention messages to parents.

Continued Assessment and Adaptation of Model-Based Interventions

Following the initial development and implementation of the model-based interventions, further intervention adaptation was actively pursued through formative evaluation of specific intervention activities using the IMPART model. As well, the overall intervention was considered, with specific attention to balancing the focus of activities across the *Stages of Change*. At regularly scheduled intervention team meetings, implementation data were reviewed and activities were evaluated. Alterations to activities were made as needed to increase utility, such as incorporation of the roulette wheel into the health fair activities.

Statistical Techniques

Descriptive statistics, such as percents and means, were based on the actual sample size, using standard statistical formulas, without any weighting or adjustment for community size. Statistical comparisons were performed using multilevel logistic regression models to account for clustering of observations, induced by participants being nested within communities, or multiple responses being nested within participants. Comparisons of participant characteristics across exposure groups were conducted using trend tests, which were computed using each characteristic as the dependent variable in a multilevel logistic regression model, with respondents nested within community, and treating exposure group as an independent variable.[39] To test the association between correctness of response to antibiotic knowledge questions and the level of exposure to education materials, questions were nested within participants, and participants were nested within community.

The two-level models were fitted using Stata 9 statistical software (StataCorp LP, College Station, TX), and the three-level model was fitted using MLwiN2 statistical software (Centre for Multilevel Modelling, University of Bristol, UK).[39]

RESULTS

Survey and Data Analysis Findings

Evaluation of IMPART community interventions was conducted in two ways. First, the distribution of intervention materials was closely tracked and community penetration of these materials was assessed, including comparisons between small (<50,000) and large (≥50,000) rural communities. Second, structured interviews were conducted in study communities with participants selected using the intercept method of sampling.[40] Sites for intercept interviews included places commonly frequented by community residents (such as the post office or a grocery store) during systematically identified dates and times. Questions were programmed into personal data assistants (PDAs) to allow for direct entry of responses by study personnel. The questions posed included exposure to printed study materials, knowledge regarding appropriate use of antibiotics, perceived threat from antibiotic resistance, actions taken to reduce antibiotic use, encouragement of others to actively reduce antibiotic use and, if they had received it, whether they had used the SCG for self-management of illness. In person interviews were used to assess respondent understanding of items and the response options.

Recognition of material was considered unprompted when the participant was able to name, or accurately describe, educational material from the IMPART project. Prompted recognition was indicated when participants reported having seen materials only after being shown a likeness. These responses were validated by questioning participants where the materials had been seen.

Participants were divided into three tiers of exposure to IMPART materials on the basis of their responses to these questions. High exposure was defined as unprompted recognition of IMPART materials or self-report of having the SCG in his or her home. Low exposure was classified as prompted recognition of IMPART materials only. No exposure was lack of recognition, prompted or unprompted, of any of the IMPART materials. Approximately 200 interviews were conducted in each of the four largest communities, 100 interviews in the four medium sized communities and 50 interviews in the four smallest communities.

Formative Evaluation

The community team performed an internal review of the quality of implementation of each component of the intervention at the end of the project. On-site assessments were also routinely performed by field personnel. Implementation success was evaluated according to whether expectations and goals were met. During the redesign process, community speakers bureau were considered to be have a high emphasis on action and maintenance (Figure 1). However, the community speakers' presentations fit poorly with established community activities. Because the venues generally were not facilitative of discussion of health-related issues, interactions between presenters and audience were limited. It was also difficult to ensure that the presenters were adequately trained and to monitor the quality of the presentations. In contrast, the success of health fair interventions exceeded expectations. Community health fairs were an efficient way to reach a large number of individuals. The intervention team was able to exert greater control of the message delivery in health fair settings. The health fair intervention incorporated an element of fun, leading to greater engagement of community residents. Those who attended the health fairs often waited in line to participate in the interactive, educational activities.

Evaluation of Penetration and Exposure

Whereas the distribution of brochures and posters continued to be a substantial aspect of the intervention following the redesign, a clear outcome of the process was the emphasis on distribution of self-care guides and personal interactions with community members through health fairs and, to a lesser extent, through community speakers' presentations (Table 1). There was also a transition from visiting community leaders prior to the redesign to visits to sites that were integral to the implementing the intervention, including community clinics, pharmacies and schools.

Table 1. Community Penetration and Intervention Implementation Before and After Redesign

	Pre-Redesign	Post-Redesign
Total Field visits (number of distinct trips)	16	94
Community Resources / Leaders visited		
Mayors	12	0
Health Departments	9	1
School Superintendents	12	5
Sites Visited		
Clinics	20	137
Pharmacies	21	37
Schools	3	33
Number of Health Fairs	0	25
Number of People Who Attended Health Fairs	0	58,932
Community Speakers Presentations	0	58
Editorials/Newspaper Articles Published	20	14
Educational Materials Distributed		
Posters	799	2,140
Brochures	31,149	70,267
Self-Care Guides	0	32,115

The per capita distribution of self-care guides and brochures was approximately two fold higher in the eight small communities than the four larger communities, while the placement of posters was roughly equivalent (Table 2). Intercept interview respondents were more likely to recognize materials disseminated by the IMPART project than they were to identify with the project regardless of community size. About 3% of respondents recognized the IMPART project while more than one in ten respondents reported having been exposed to IMPART materials.

Exposure To and Use of IMPART Materials

Respondents reported having seen or read newspaper articles about antibiotic resistance more frequently than having seen or read IMPART brochures or posters (22%, 11% and 7%, respectively, $P < 0.001$). Thirty-four percent who reported reading a poster and 48% of those who reported reading a brochure also reported that they discussed these materials with family and friends. The predominant site of reported exposure to IMPART materials was medical clinics.

Active use of materials was also reported for the self-care guide, with 13% having seen the SCG, 62% having a copy in their home and of these, 32% reported talking to family or friends about the information contained in this guide. For those with a SCG in the home and a family member with a cold during the past year, 64% had used the SCG during the previous year, with 69% using it to decide whether to see the doctor and 76% using it to treat the illness at home.

Comparisons among Exposure Groups

Age was inversely related to level of exposure and those with any exposure were more likely to be female (Table 3). Those not exposed to the intervention were also less likely to report that either they or a family member had suffered from a respira-

Table 2. Material Distribution and Reported Exposure to Materials by Community Size

	Small Communities	Large Communities
Material distribution	(Pop <50,000) (No. = 8)	(Pop ≥ 50,000) (No.= 4)
Community Size Median (range)	14,560 (2,054-25,597)	70,836 (60,654-96,332)
Distribution of Materials Per 1000 Population Median (range)		
Posters	4 (1-16)	3 (1-21)
Brochures	377 (106-528)	175 (56-732)
Self-Care Guides	134 (76-348)	72 (53-120)
Reported exposure	[No. = 603] f (%)	[No. = 820] f (%)
Heard of IMPART	21 (3.5)	21 (2.6)
Seen IMPART Materials (Unprompted)		
Posters	8 (1.3)	0 (0)
Brochures	5 (0.8)	1 (0.1)
Self-Care Guides	5 (0.8)	10 (1.2)
Seen IMPART Materials (Prompted)		
Posters	70 (11.6)	62 (7.6)
Brochures	70 (11.6)	86 (10.5)
Self-Care Guides	84 (13.9)	82 (10.0)

tory illness during the previous year. Higher levels of exposure to intervention materials were associated with increased knowledge of when antibiotics were appropriate and an increased sense that antibiotic use by others was a threat to their health.

The association between obtaining a correct response to the three appropriate antibiotic knowledge questions and exposure group was demonstrated in a multilevel model nesting question responses within person and person within community, controlling for respondent age and community size. The odds of providing a correct response to a knowledge question was 2.02 times higher (95% CI = 1.51, 2.69; $P < 0.001$) for respondents in the high exposure group and 1.27 times higher (95% CI = 1.05, 1.54; $P = 0.012$) for respondents in the low exposure group compared to those who reported no exposure.

DISCUSSION

We implemented and conducted a formative evaluation of a rural community-level intervention to address overuse of antimicrobial agents. We re-designed the community intervention midway through the first project year on the basis of a multi-theoretical behavior change model. Our experience corroborated the prediction that active interventions have increased potency compared to passive distribution of information.

Due to unexpected pitfalls; not all of the interventions worked as planned. Our qualitative assessment of the implementation process revealed that the factor which had the strongest influence on success was the relevance of the intervention component to already-established community infrastructure. Thus, the health fair activity was substantially more effective than the community speakers' bureau because it engaged community residents in the context of an existing and popular community event.

The intercept interviews indicated that the SCG was favorably received and that it had a positive effect on knowledge of appropriate antibiotic use. Although fewer copies of the SCG were distributed than brochures, similar proportions of community residents recalled seeing each of these materials. Further, the SCG dissemination was often active as distribution occurred through health fair activities, community speakers, or in clinic settings. While there were significantly increased odds of providing correct responses to antibiotic knowledge questions among respondents that demonstrated exposure to intervention materials, it is notable that meaningful improvement over those respondents with no exposure only occurred among those with high exposure.

While IMPART targets rural communities generally, it is clear that differences exist across rural communities, especially among large versus small rural communities. Penetration of materials was greater for small communities, yet recall of exposure to study materials remained surprisingly constant (Table 2), suggesting that factors other than simple availability of materials impacts recall. Further understanding of these factors may provide insights into designing more

Table 3. Intercept Survey Responses by Exposure Groups

	No Exposure [No. = 1,047] f (%)	Low Exposure [No. = 255] f (%)	High Exposure [No. = 121] f (%)	P trend[a]
Respondent Characteristics				
Age, years				
18 to 35	304 (30.1)	107 (43.7)	60 (53.6)	
36 to 55	345 (34.1)	91 (37.1)	41 (36.6)	
55 or older	362 (35.8)	47 (19.2)	11 (9.8)	<0.001**
Female	689 (68.2)	205 (84.0)	95 (86.4)	<0.001**
Respondent or family member with cold, sinus congestion, sore throat, earache, cough or flu during past year	766 (73.2)	222 (87.1)	104 (86.0)	<0.001**
Knowledge				
Antibiotics needed to treat bronchitis No (correct answer)	652 (62.3)	171 (67.1)	87 (71.9)	0.017*
Feel better from cold or flu with antibiotics No (correct answer)	776 (74.1)	214 (83.9)	107 (88.4)	<0.001**
Need antibiotics for green or yellow runny nose No (correct answer)	709 (67.7)	169 (66.3)	90 (74.4)	0.294
Threat				
Does respondent think inappropriate use of antibiotics by others is a threat to his or her health?	555 (53.0)	159 (62.4)	84 (69.4)	<0.001**

[a] All *P* values are for a linear trend across exposure level.
* $P < 0.05$
**$P < 0.01$

efficient community interventions.

It is notable that the Transtheoretical model,[29] which includes *Stages of Change,* was developed to describe the process of people experience during smoking cessation. This model has been applied to other health issues that require sustained behavior change, such as physical activity for weight loss. However, illnesses that may lead to inappropriate antibiotic use occur episodically, requiring that behavior change promotion needs to occur preventively. With preventive behavior change promotion, the goal is that appropriate behaviors will be enacted during these episodes when antibiotic use is in question as opposed to being more regularly enacted as with chronic application. Enactment of the positive behaviors associated with reduced antibiotic seeking are likely to successfully occur, even with the episodic nature of these illnesses, by promoting patient efficacy to engage in appropriate care seeking behaviors.

Although antibiotic use takes place at the individual level, the consequences of overusing antibiotics largely occur at the community or societal levels. This removes much of the direct motivational link between preventive behaviors and avoidance of negative outcomes at the individual level. Thus, the tactics of improving patient communication with healthcare providers, and taking steps to self-manage illness in order to avoid unnecessary clinic visits, offer additional motivating benefits. These behaviors must be adopted sufficiently to substantially reduce unnecessary antibiotic use and combat emerging antimicrobial resistance.

Past work has demonstrated that effective communication between parents and health care providers may reduce demand for antibiotics, even when information regarding the negative effects of overuse of antibiotics is not supplied.[41] This is consistent with our IMPART findings, that more may be done in the clinic setting to actively utilize the SCG as both a clinic tool and a home guide. Further work in developing materials similar to the SCG, as guides for self-management of other diseases, may also be warranted.[24,42-45]

By actively promoting materials such as the SCG and by identifying positive actions that can be taken for health issues, the IMPART community intervention provides an approach that may be replicated. Further, results of the evaluation of the IMPART community interventions associate exposure to materials with enhanced levels of knowledge that are likely predictors of future appropriate health behaviors. Specifically, in the case of the SCG, activity related to increasing the appropriate use of antibiotics was observed. Furthermore, study participants indicated promotion of the innovative SCG to others as a means of guiding action about common respiratory illness. While increasing knowledge through information-based interventions can serve as a foundation for appropriate health behavior, motivating action may require interventions that extend beyond the pre-action states within the *Stages of Change* model.

The IMPART community intervention demonstrates that there is utility in using community-based interventions to promote appropriate health behaviors. This benefit can be strengthened by the use of health behavior theory to guide the development of interventions that focus on specific, positive actions. The success of interventions focusing on behavior rather than knowledge is less reliant on the capacity of recipients to translate knowledge into appropriate actions. Interventions like the SCG may provide a model that is relevant to a wide variety of health issues. Using a theoretical framework provides a grounded means for promoting appropriate behaviors. Targeting positive action rather than focusing on inappropriate actions may also be more effective in achieving desired health behaviors.

TRANSLATION TO HEALTH EDUCATION PRACTICE

This experience demonstrated the practical benefits of using a model to guide prioritization and development of intervention activities. Rather than solely testing theoretical validity of cognitive processes which underlie behaviors, we used our model to help transition from an educational approach to a successful strategy emphasizing promotion of self-management and improved patient-healthcare provider communication. Adapting our methods to other disorders may provide further insights into the feasibility of our approach to health education.

Developing and disseminating the SCG was essential to guiding patients in improving their interactions with healthcare providers to optimize communication and treatment for illnesses. The concept of the SCG fit well within a framework of patient-centered care and the emergence of consumer health informatics. As a resource which educates people about when disease can be self-managed, and when to consult a healthcare provider, the SCG has facilitated increased control of health and illness.

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