Application of system dynamics modeling to inform implementation of adolescent SBIRT in primary care settings

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Abstract

We apply system dynamics (SD) modeling to better understand the influence of different implementation strategies on the effective implementation of screening and brief intervention. Using qualitative and quantitative data from an on-going cluster randomized trial in 8 federally qualified health center sites, two implementation conditions were compared: Generalist vs. Specialist. In the Generalist Approach, the primary care provider (PCP) delivers brief intervention (BI) for substance misuse (n=4 clinics). In the Specialist Approach, BIs are delivered by behavioral health counselors (BHCs) (n=4 clinics). We used our SD model to compare 'basecase' dynamics to strategic approaches to deploying Continuous Technical Assistance (TA) and Performance Feedback Reporting (PFR). We calibrated our basecase to effectively represent the SBIRT intervention, which reflected actual monthly volume of adolescent primary care visits (N=9,639), screenings (N=5,937), positive screenings (N=246), and brief interventions (BIs; N=50) over the 20-month implementation period. Insights gained suggest that implementation outcomes are sensitive to frequency of PFR, with bimonthly events generating the most rapid and sustained screening results. Simulated trends indicate that availability of the BHC directly impacts success of the Specialist model. Similarly, understanding PCPs' perception of severity of need for intervention is key to outcomes in either condition.

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Introduction

In this paper we present an application of system dynamics (SD) to examine strategies for implementing the Screening, Brief Intervention and Referral to Treatment (SBIRT) model in a multi-clinic, urban primary care facility for low income families. The SBIRT model described here targets substance use and other risky behaviors in high-school aged youth who visit the facility for either well- or sick-care. Clinical trials and meta-analyses evidence supports the effectiveness of SBIRT for adolescents with substance misuse, but primary care providers have been slow to adopt this evidence-based approach in routine, clinical practice. Thus, research is needed to determine effective ways to implement SBIRT for adolescent substance misuse so that this approach can be brought to scale. SD modeling was used to help inform new organizational procedures and policies that adequately address implementation challenges and support the long- term sustainability of the intervention.

Procedures for building and validating the SD model were embedded within a parent research project (Mitchell, PI; National Institute of Drug Abuse grant 1R01DA034258-04), which aims to contribute to the growing field of implementation science field. Implementation science is a nascent field and a number of conceptual models have recently been proposed to guide research efforts (Damschroder, Aron, Keith, et al., 2009; Fixsen, Naoom, Blase, Friedman, & Wallace, 2005; Proctor, Landsverk, Aarons, et al., 2009; Simpson & Flynn, 2007). Proctor and colleagues' model of implementation research (Proctor et al., 2009; Proctor, Silmere, Raghavan, et al., 2011) links key implementation strategies with implementation outcomes.

Prevalence and impact of substance use and other risky behaviors in adolescents. Alcohol, tobacco, and other drug use remains highly prevalent among US adolescents and is a threat to their well-being and to the public health. In the United States, approximately one in ten youth under the age of 18 reports using illicit drugs, tobacco, or binge alcohol drinking in the past month (Substance Abuse and Mental Health Services Administration, 2010) and while recent studies have shown an overall decline in reported use of illicit drugs, findings from the most recent Monitoring the Future survey indicated that 37% of 12th graders reported past-month use of alcohol, 35% reported use of marijuana in the past year, and that use of non-prescribed medications such as Adderall, Vicodin, and tranquilizers in the past year ranged from 4.7 to 6.8% (Johnston, O'Malley, Bachman, Schulenberg & Miech, 2014).

Youth with more severe substance use issues often experience significant difficulties with school performance (Miller, Naimi, Brewer, & Jones, 2007), while many more were no longer engaged in school by the 12th grade, indicating that these figures likely under-represent the extent of substance use and related problems. More particularly, studies have found that deleterious short-and long-term consequences of substance use include mental health problems (Mathers, Toumbourou, Catalano, Williams, & Patton, 2006; Moore, Fiellin, Barry, et al., 2007), deteriorating school performance (Miller et al., 2007), risky sexual activity and victimization (Fergusson & Lynskey, 1996; Miller et al., 2007), placing oneself in danger by riding with an impaired drive (Miller et al., 2007), suicide attempts (Windle, 2004), and elevated risk of mortality (Clark, Martin, & Cornelius, 2008). Moreover, it has been reported that substance misuse during adolescence may negatively impact critical stages of brain development (Volkow & Li, 2005; Lubman, Yucel & Hall, 2007). Perhaps the most obvious long term consequence of substance use in adolescence is that it increases the risk for substance use disorders later in life (Englund, Egeland, Oliva, & Collins, 2008; Hingson, Heeren, & Winter, 2006; Mathers et al., 2006; McCambridge, McAlaney, & Rowe, 2011; Swift, Coffey, Carlin, Degenhardt, & Patton, 2008). These findings have led to a concern with developing better screening and interventions for the range of substance use issues, which has led in turn to the development of the SBIRT model.

Screening, Brief Intervention and Referral to Treatment. SBIRT typically uses universal screening (S) with validated brief self-report questionnaires to identify those at-risk for substance use problems

(Knight, Sherritt, Harris, Gates, & Chang, 2003; Knight, Sherritt, Shrier, Harris, & Chang, 2002; Reinert & Allen, 2007). Those who screen positive are given a Brief Intervention (BI), or a referral to treatment (RT) if specialized treatment for substance use disorders appears warranted. In this way, SBIRT can be employed to address varying degrees of substance use severity. In randomized clinical trials with adolescent populations in school and health care settings, brief interventions were found to significantly impact consumption of alcohol, tobacco, and marijuana (McCambridge & Strang, 2004); smoking frequency and to increase long-term cessation (Colby, Monti, O'Leary, et al., 2005; Heckman, Egleston, & Hofmann, 2010; Hollis, Polen, Whitlock, et al., 2005; Peterson, Kealey, Mann, et al., 2009); use of alcohol (Monti, Colby, Barnett, et al., 1999; Spirito, Monti, Barnett, et al., 2004); both use of alcohol and anti-social aggressive behaviors (Walton, Chermack, Shope, et al., 2010); attempts to quit drinking (Bernstein, Heeren, Edward, et al., 2010); frequency of drug use and related consequences (Winters & Leitten, 2007); marijuana use; number of friends smoking marijuana (Bernstein, Edwards, Dorfman, et al., 2009; D'Amico, Miles, Stern, & Meredith, 2008; Martin & Copeland, 2008); and referral to substance abuse treatment (Tait, Hulse, & Robertson, 2004). Meta-analyses of RCTs in a variety of settings of BIs for adolescent substance use have obtained positive findings (Tait & Hulse, 2003; Tripodi, Bender, Litschge, & Vaughn, 2010).

Most adolescents in the US see a healthcare provider at least annually, making primary care an ideal venue in which to deliver substance misuse interventions for this population (Newacheck, Brindis, Cart, Marchi, & Irwin, 1999). Unlike traditional substance abuse treatment or extended prevention programs, SBIRT is a service model that is well-suited for integration into primary care (Erickson, Gerstle, & Feldstein, 2005). Although the USPSTF states that support for providing BIs in primary care is limited, both the American Academy of Pediatrics and the NIAAA recommend that pediatricians provide substance use screening and counseling to all adolescents (American Academy of Pediatrics, 2010). However, the majority of physicians do not follow this recommendation (Millstein & Marcell, 2003).

Assessment of implementation strategies via simulation modeling. Although human service delivery systems, such as the multi-site primary care facility used in the current project, are complex and arguably “. . . not predictable . . . it is possible to achieve a level of understanding of a complex system by studying how it operates” (p. 177). Working in collaboration with selected clinic-based project stakeholders, we developed a system dynamics (SD) model that simulates the effects of two key implementation strategies deployed in the current research project, namely: Continuous Technical Assistance (TA) with site-specific Performance Feedback Reporting (PFR). TA includes integrated team development of SBIRT service delivery model, including useful modifications to the electronic medical record, initial training of staff (i.e., Medical Assistants, MAs; primary care physicians, PCPs; and clinic administrators), staff debriefing/informal following guidance, and periodic educational ‘booster’ sessions. PFR includes periodic aggregated (i.e., clinic-level) and provider-specific performance reporting to with to all staff accompanied with supervision.

The SD model is designed to simulate the effects of both TA and PFR on dynamics associated with the adolescent SBIRT, namely aggregate adolescent screenings, positive (risk endorsed) adolescent screenings, and BIs – relative to hypothesized an expected positive screening rate adjusted for adolescent ‘under reporting’ and PCPs’ perception of the severity of adolescents’ substance use and/or potential harm due to self-reported risky behavior(s). The specific aim of this work was to develop and validate a SD model as a visual interface for structured play, or gaming, by health care providers and other important stakeholders who to effectively implement and sustain the adolescent SBIRT model in their setting.

Methods

Parent project design. The parent research project's protocol is a multi-site, cluster randomized trial (N= 8) guided by Proctor's conceptual model of implementation research (Proctor et al., 2009; Proctor, Silmere, Raghavan, et al., 2011) and comparing two principal approaches to SBIRT delivery within adolescent medicine: *Generalist* vs. *Specialist*. In the Generalist Approach, the primary care provider delivers brief intervention (BI) for substance misuse (n=4 clinics). In the Specialist Approach, BIs are delivered by behavioral health counselors (n=4 clinics).

Statistical analyses of intervention data showed that there were no significant differences by Generalist or Specialist condition during the 20-month implementation period on penetration of screening (p=.55), brief advice (p=.70), or brief intervention (p=.58). There were significant time period differences in screening (above and beyond differences by Site and Condition), but not for Brief Advice or Brief Intervention (Note: This is likely due to very low numbers receiving BA or BI). There was significant variation by Site in penetration of screening, BA, and BI. While both service delivery models showed promise for delivering BIs, the high rates of variability within sites demonstrate a need for further examination.

Overview of SD modeling approach. SD model-building deploys an iterative research process that is complete when the model achieves sufficient *structural* and *behavioral* validity to its intended purpose (Barlas, 1989, 1996; Martinez-Moyana & Richardson, 2013; Martinez-Moyano, 2012). Procedures for establishing structural and behavioral validity are organized around the purpose of the model, the type and quality of the sources of evidence, and model calibration. In the current study, the purpose of the SD model is to help inform new organizational procedures and policies that adequately address implementation challenges and support the long term sustainability of the intervention. The featured SD model is a working set of algebraic and ordinary differential equations, generally shown as a stock-and-flow diagram. With input and deliberation among the research project team and other project stakeholders, we followed established procedures for model building (see Roberts, Anderson, Deal, Garet, & Shaffer, 1983), including problem identification, system conceptualization, model formulation, model simulation, and, finally model evaluation.

Assessment of model performance. We conducted a variety of tests to ensure that the current SD model adhered to established validation tests, following recommendations by (Forrester & Senge, 1980). Specifically, we conducted (1) verification tests to confirm that parameter estimates were logical, supported by one more sources of information, and properly entered; (2) validation tests to address the extent to which the simulated behavior of the model was realistic or like the actual 'real world' dynamics it is intended to represent; and (3) legitimation tests, which affirm that the differential equations use to construct the model followed commonly accepted mathematical principles, namely that they were dimensionally valid (i.e., the units of measurement or quantification of the constructs or variables on each side of the equation should be the same), and, for material (i.e., physical) variables, the model should maintain 'conservation of flow.' (i.e., what enters the system should be accounted for at any point within the model's time horizon). Face-to-face and on-line meetings with key project stakeholders were conducted at project milestones (start-up, implementation phase initiation, implementation phase completion, sustainability phase completion). Vensim software was used to create the SD model and simulate outcomes (Ventana Systems Inc., 2008).

Sources of SD modeling data. Our system dynamics model is informed by quantitative data obtained through the parent project's multi-site, cluster-randomized design and by qualitative input obtained from stakeholders, namely MAs, nurses, PCPs, BHCs, and administrators. Five data sources are available to support our proposed SD modeling: (1) Training data – detailed records of initial and booster training sessions (longitudinal; see Appendix); (2) Patient visit and screening data – number of adolescents and non-adolescents (medical records, individual patients, longitudinal); (3) Staffing data – clinical staffing and staffing turnover (longitudinal); (4) Structured provider interviews and semi-structured qualitative provider interviews about knowledge of barrier and facilitators (baseline and follow up during sustainability period); and (5) Organizational impact data about either facilitators or inhibitors of the intervention's implementation, such as catastrophic breakdown of a clinic's electronic medical records systems or an abrupt change in clinic leadership priorities relating to the intervention.

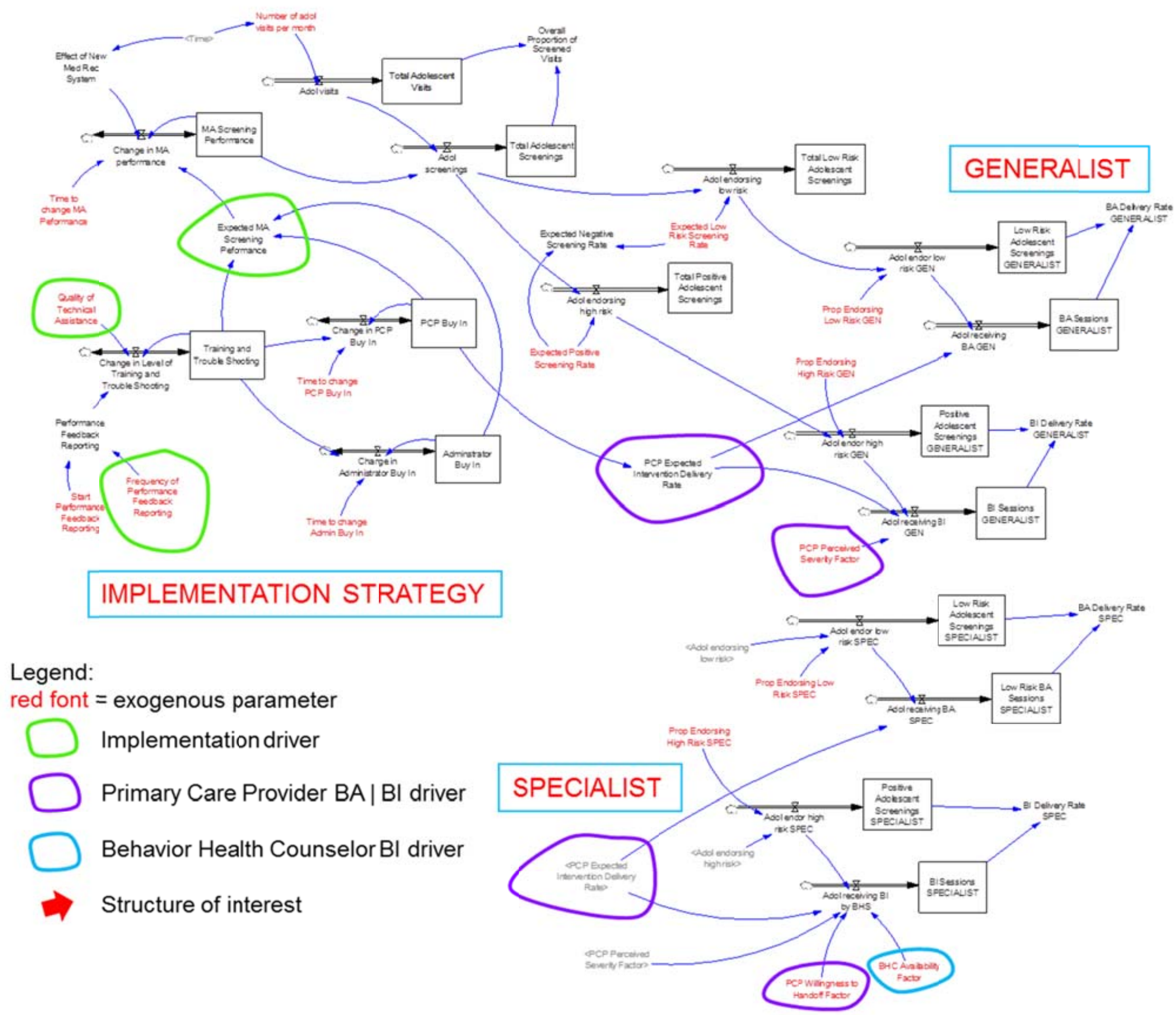
SD model variables and parameters. Figure 1 presents a stock-and-flow diagram of our SD model of adolescent SBIRT implementation strategy dynamics. The SD model structure is designed to simulate patient flow and SBIRT delivery across health system. The model is organized into three substructures ('Implementation strategy,' 'Generalist,' and 'Specialist'). The 'Implementation Strategy' substructure includes the structures that represent patient visits, screenings, positive screenings, and interventions (BIs) for adolescents aged 12-17 who visit any of the seven clinics that comprise the participating care facility. We utilized the first-order smooth to simulate effect of key implementation constructs: Performance Reporting (PFR) frequency; Quality of Technical Assistance (TA). Three first-order smooth structures represent staff performance and engagement, including the performance of MAs (who are charged with administering the screening of adolescents), the clinic administrators (who are charged with overseeing implementation and sustainability of the SBIRT intervention, and the PCPs (who are charged with actually delivering the BI). Note that organizational buy-in by PCPs and administrators partially mediate the effect of TA and PFR on the MA's screening performance.

We applied the 'smooth' structure to represent information delays for each of these major constructs, as it allowed us to test hypotheses about the potential effect of deployed implementation strategies (i.e., TA and PFR) on how long it takes, on average, to change the behavior of clinic MAs, PCPS, and administers. An additional smooth structure was used to represent the effect of 'training and trouble-shooting,' which was derived from parameters that defined the quality of TA and the frequency of PFR. The 'Generalist' and the 'Specialist' substructures, respectively, allow for comparison of simulated outcomes between the two intervention conditions of the parent study. These substructures simulate rates and accumulation BA and BI delivery, over time.

Finally, there are 16 exogenous parameters (shown in red font in Figure 1) that are used to define our basecase (calibrated) scenario and comparison scenarios. These exogenous parameters are essentially 'drivers' or effect sizes, of the implementation strategy (parameters circled in green), or the intervention itself (BA or BI), which is a function of either the performance of the PCP (parameters circled in purple) or the performance of the Behavioral Health Counselor (BHC; parameters circled in aqua blue). The definitions and the range of values for these drivers were informed by qualitative and quantitative data from the study.

Minimum and maximum values for exogenous parameters were purposefully defined with available data as well as discussion among the research team and about how best establish meaningful, easy-to-interpret, range of values that supported comparison scenarios of interest. For example, quality of TA was defined as on-going assistance, punctuated by monthly site visits by research staff, to address questions that clinic staff may have had and to check to see if new staff were aware of the aSBIRT implementation effort. The range of values for quality of TA was set to be as low as 1 and as high as 10. We chose 5 for our basecase because, although the research staff manager and trainer made regular visits, reach to staff at any given visit was sporadic. Similarly, time to change PCP Buy In to the intervention (i.e., PCP's awareness, understanding and motivation to support the SBIRT intervention) was set to 6 months. This 'average' parameter value was chosen considering all PCPs in the clinics and PCP turnover rates. Comparatively, the 'average' time to change Administrator Buy In was set to 12 months and the average time to change MA Screening Performance was, on average, just 1 month. The higher (longer) parameter value for Administrators reflects qualitative observations about how all administrators in the health system, including evidence that Administrators had more turnover than PCPs. The very low (short) time to change MA Screening Performance was assigned based on the assumption that their job was dedicated to the intervention, and that they would be response to their PCPs' and Administrators' supervision.

Other important drivers included PCP Perceived Severity Factor and PCP Willingness to Handoff Factor. PCP Perceived Severity was set to 1.3 for the basecase. This parameter was defined as the PCPs' likelihood to respond to a 'high' risk vs. a 'low' risk patient, which was an artifact of the PCP's personal, subjective judgment. This parameter range was from 0 to 2, which allowed for use of interesting mathematical properties (i.e., if set to 0, no BIs would be delivered by the PCP). In our basecase, PCP Willingness to Handoff Factor was set to 0.26, to match the proportion that were documented in charts as handed off to the BHC. And this value could be as low as 0 or as high as 1.0, which, again, allows for examination of special circumstances, where BHC may be complete obstructers or facilitators of BI delivery.



Results

Our basecase implementation scenario (i.e., the scenario representing actual deployment of the SBIRT at participating clinics) was compared to 8 scenarios of interest (see Tables 1-3). Supported by qualitative and quantitative data from the study, we calibrated our basecase to effectively represent the SBIRT intervention, which reflected actual monthly volume of adolescent primary care visits (N=9,639), screenings (N=5,937), positive screenings (N=246), and brief interventions (BIs; N=50) over the 20-month implementation period. We then varied the value of five selected drivers, to illustrate tradeoffs in implementation outcomes. Selected drivers included to implementation drivers (i.e., frequency of PFR and quality of TA), two PCP performance drivers (i.e., PCP perceived severity and PCP willingness to handoff adolescent patients to the BHC), and one BHC driver (i.e., BHC availability).

Table 1 shows parameterization for our basecase and three scenarios that explore the medical assistant' screening performance. Comparison of simulated output shows that screening performance varied in relationship to the frequency of performance feedback reporting (PFR). Our basecase scenario (bimonthly PFR) showed screening rates to rise rapidly over the initial 6 months of the implementation period to 68% of all adolescent visits, dipping slightly due to transition to a new electronic medical records (EMR) system, then recovering and leveling off at approximately 70%. Decreasing PFR to quarterly, semiannual, or annual intervals generated diminished screening patterns (Scenarios 1-3; see Table 1 and Figure 1).

Table 1 - MA screening performance rate

Simulation Scenario	Parameter description				
	Frequency of performance feedback reporting	Quality of technical assistance	PCP perceived severity (dmnl)	PCP willingness to handoff (dmnl)	BHC availability (dmnl)
	Parameter range				
	.25 to 12	1 to 10	0.0 to 2.0	0% to 100%	0% to 100%
Basecase	Bimonthly	Average	Somewhat more severe	Somewhat unwilling	Half of the time
	2	5	1.3	26%	50%
Scenario 1	Quarterly	Average	Somewhat more severe	Somewhat unwilling	Half of the time
	3	5	1.3	26%	50%
Scenario 2	Semiannual	Average	Somewhat more severe	Somewhat unwilling	Half of the time
	6	5	1.3	26%	50%
Scenario 3	Annual	Average	Somewhat more severe	Somewhat unwilling	Half of the time
	12	5	1.3	26%	50%

Figure 1 - Medical Assistants' Screening Performance

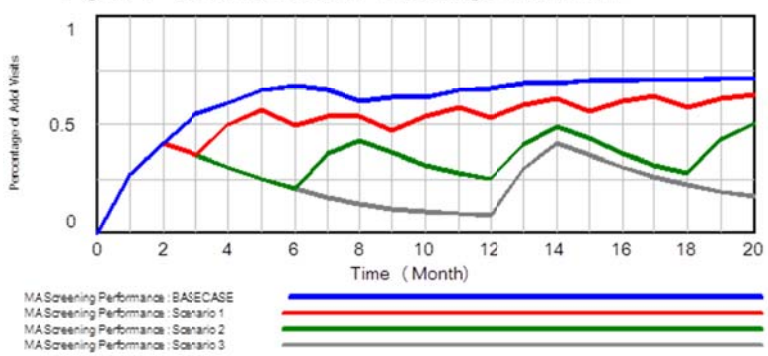


Table 2 shows the parameter values for BI delivery rate in the Specialist condition only. Examination of BI delivery rates for the Specialist condition, where availability of the Behavioral Health Counselor (BHC) varied from 25% to 100%, showed that, as expected, higher BHC availability generated higher BI delivery rates, although never exceeded 10% of positively screened adolescents (Scenarios 4-6; see Table 2 and Figure 2).

Table 2 - BI delivery rate, Specialist Only

Simulation Scenario	Parameter description				
	Frequency of performance feedback reporting	Quality of technical assistance	PCP perceived severity (dmnl)	PCP willingness to handoff (dmnl)	BHC availability (dmnl)
	Parameter range				
	.25 to 12	1 to 10	0.0 to 2.0	0% to 100%	0% to 100%
Basecase	Bimonthly	Average	Somewhat more severe	Somewhat unwilling	Half of the time
	2	5	1.3	26%	50%
Scenario 4	Bimonthly	Average	Somewhat more severe	Somewhat unwilling	A quarter of the time
	2	5	1.3	26%	25%
Scenario 5	Bimonthly	Average	Somewhat more severe	Somewhat unwilling	Three quarters of the time
	2	5	1.3	26%	75%
Scenario 6	Bimonthly	Average	Somewhat more severe	Somewhat unwilling	All of the time
	2	5	1.3	26%	100%

Figure 2 - BI Delivery Rate - SPECIALIST Only

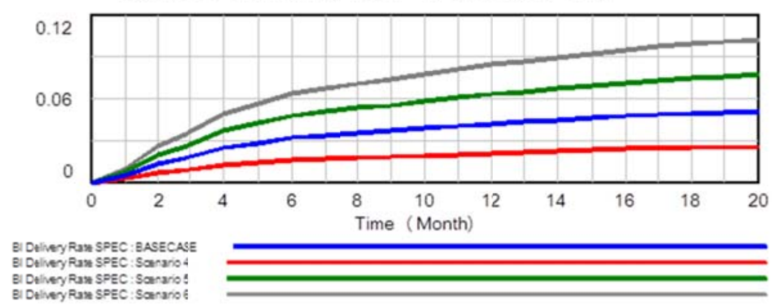
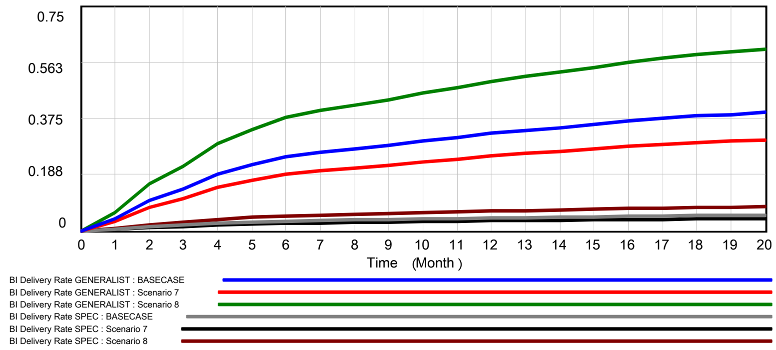


Table 3 shows the parameter values for BI delivery rates, comparing Generalist to Specialist conditions. Comparison of simulated differences in the PCP's likelihood to respond to a positive vs. a low risk adolescent patient (i.e., perceived severity) revealed high sensitivity, with BI delivery rates increasing from 39% to 61% (GENERALIST) and from 5% to 8% (SPECIALIST) by the end of the implementation period. Notably, results for the GENERALIST condition were substantively higher than in the SPECIALIST condition for all simulated values of PCP's perceived severity (Scenarios 7-8; see Table 3 and Figure 3).

Table 3 - BI delivery rate GENERALIST vs SPECIALIST

Simulation Scenario	Parameter description				
	Frequency of performance feedback reporting	Quality of technical assistance	PCP perceived severity (dmnl)	PCP willingness to handoff (dmnl)	BHC availability (dmnl)
	Parameter range				
	.25 to 12	1 to 10	0.0 to 2.0	0% to 100%	0% to 100%
Basecase	Bimonthly	Average	Somewhat more severe	Somewhat unwilling	Half of the time
	2	5	1.3	26%	50%
Scenario 7	Bimonthly	Average	Same severity	Somewhat unwilling	Half of the time
	2	5	1.0	26%	50%
Scenario 8	Bimonthly	Average	Extremely more severe	Somewhat unwilling	Half of the time
	2	5	2.0	26%	50%

Figure 3 - BI Delivery Rate - GENERALIST vs. SPECIALIST



Initial feedback about current SD model. During a brief webinar offered in late 2015, key stakeholders from the participating health system affirmed the utility of simulated analysis for future orientation and training sessions with providers and other 'front line' providers. Preliminary experience in sharing the SD model out on key stakeholders from the parent project was successful. For example, one stakeholder noted that it would be useful and interesting to use the model to conduct a simulated break-down analysis by age group and gender. There was a hypothesis that high school age girls and boys would present with different levels of risky behavior, and that girls may be biased to endorse risk behaviors more than boys.

There was also interest in expanding the SD model to include structures that would simulate the dynamics of referral to SA treatment for those adolescents with greater risk. Another suggestion was to use the SD model to examine clinic size and clinic flow relative to size (i.e., the adolescent visit rate). Last, there was interest expressed in further consideration of how the provider interview data (qualitative) may be useful data to inform staff-related effects. Further examination of this via the SD modeling is also is warranted. More generally, there was concern from one participant about having sufficient evidence to support modeling assumptions, although there was an appreciation for simply using the model to explore various possible contingencies, over time.

Discussion

The current paper features an application of system dynamics (SD) to examine strategies for implementing the Screening, Brief Intervention and Referral to Treatment (SBIRT) model in a multi-clinic urban primary care facility for low income families. The simulation results presented here are offered as a demonstration of the potential utility of using a SD approach to guide implementation planning. The scenarios used to illustrate the SD model are limited in that, although there are thoughtful and plausible, they generate an incomplete assessment of the myriad options could be explored.

Insights gained from this set of scenarios suggest that implementation outcomes are sensitive to frequency of PFR, with bimonthly events generating the most rapid and sustained screening results. Simulated trends indicate that availability of the BHC directly impacts success of the Specialist model. Similarly, understanding PCPs' perception of severity of need for intervention is key to outcomes in either condition. Additional application of the SD model will explore post-implementation outcomes.

Conclusion

SD modeling is a robust method for comparative analyses of implementation strategies. This approach facilitates synthesis of multiple sources of information/data and can foster important insights about how to deploy limited resources for training and support in diverse clinical sites.

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APPENDIX

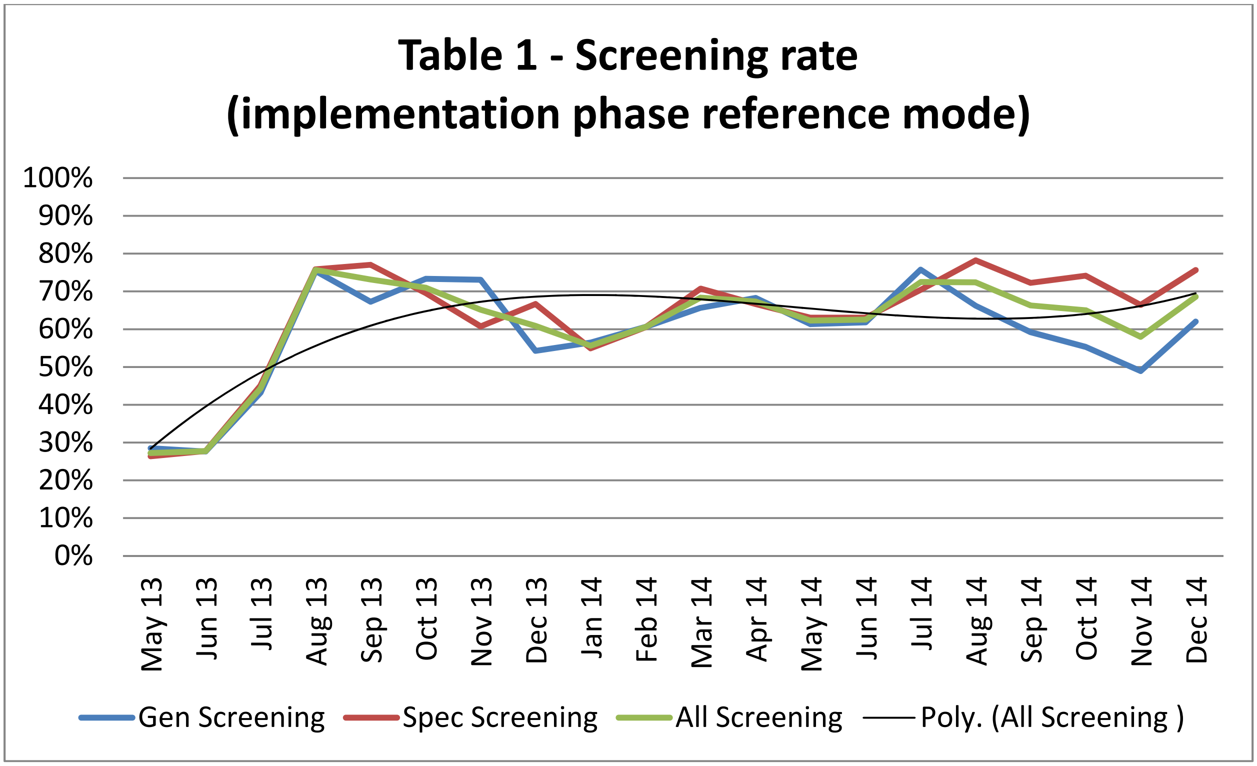
Table 1 - Screening rate
(implementation phase reference mode)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
May 13
Jun 13
Jul 13
Aug 13
Sep 13
Oct 13
Nov 13
Dec 13
Jan 14
Feb 14
Mar 14
Apr 14
May 14
Jun 14
Jul 14
Aug 14
Sep 14
Oct 14
Nov 14
Dec 14
Gen Screening
Spec Screening
All Screening
Poly. (All Screening)

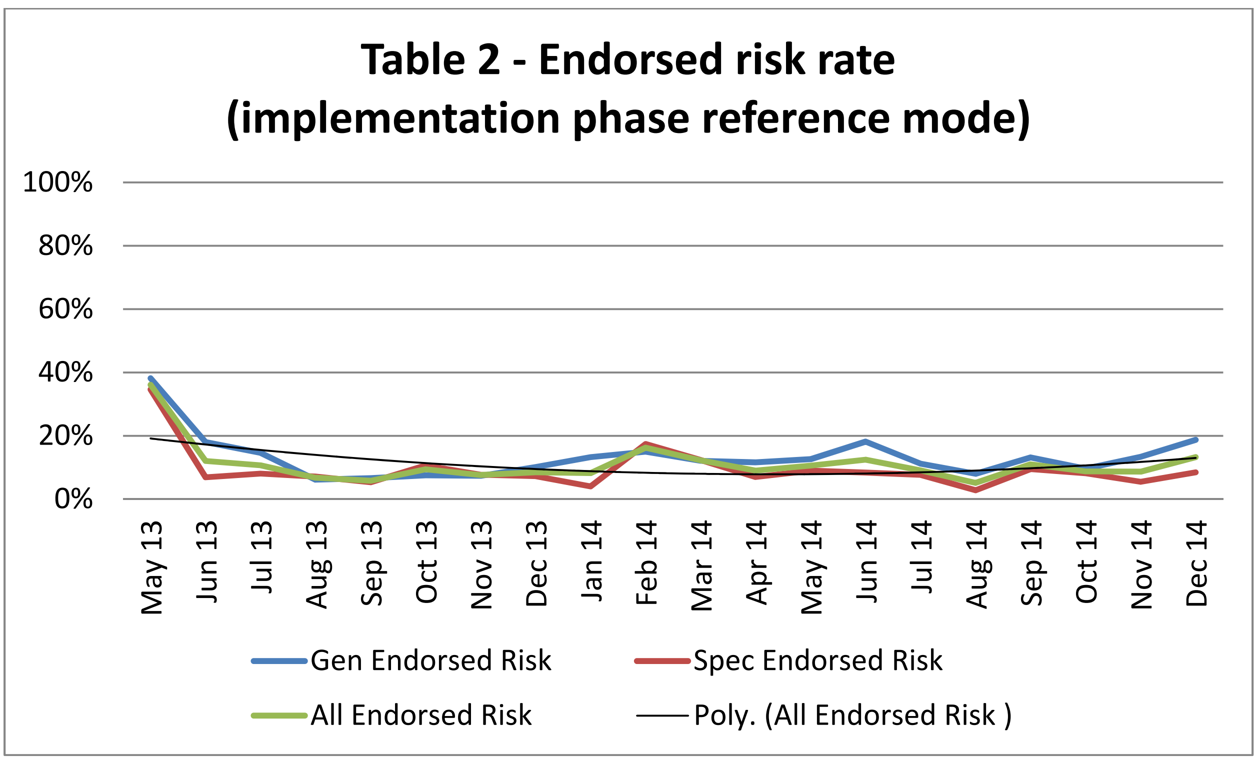
Table 2 - Endorsed risk rate
(implementation phase reference mode)
100%
80%
60%
40%
20%
0%
May 13
Jun 13
Jul 13
Aug 13
Sep 13
Oct 13
Nov 13
Dec 13
Jan 14
Feb 14
Mar 14
Apr 14
May 14
Jun 14
Jul 14
Aug 14
Sep 14
Oct 14
Nov 14
Dec 14
Gen Endorsed Risk
Spec Endorsed Risk
All Endorsed Risk
Poly. (All Endorsed Risk)

Table 3 - Intervention rate for screened adolescents (Implementation phase ref. mode)

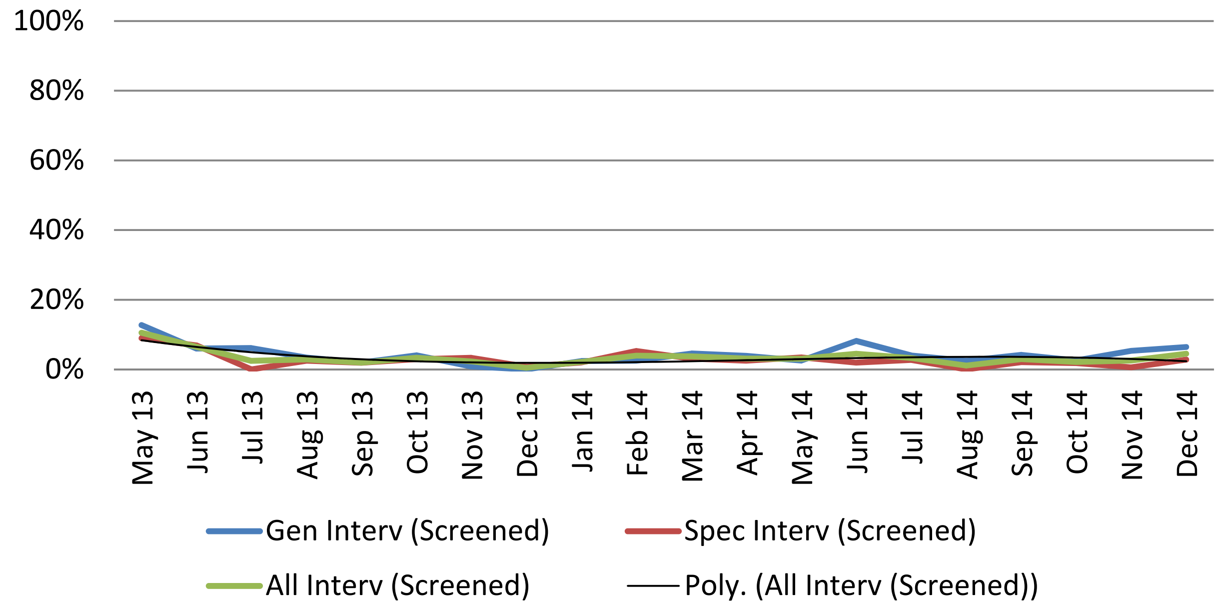

Table 4 - Intervention rate for adolescent visits (Implementation phase reference mode)