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Relevance of the interpersonal theory of suicide in an adolescent psychiatric inpatient population

Christopher D. King^{a,b}, Victoria W. Joyce^a, Evan M. Kleiman^d, Ralph J. Buonopane^{a,b,c}, Alexander J. Millner^{a,e}, Carol C. Nash^{a,*}

^a Franciscan Children's, 30 Warren St, Brighton, MA 02135, USA

^b McLean Hospital, 115 Mill St., Belmont, MA 02478, USA

^c Department of Psychiatry, Harvard Medical School, 25 Shattuck St. Boston, MA 02115, USA

^d Department of Psychology, Rutgers, The State University of New Jersey, Tillet Hall, Room 627, Piscataway, NJ 08854, USA

^e Department of Psychology, Harvard University, 33 Kirkland St, Cambridge, MA 02138, USA

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ABSTRACT

The interpersonal theory of suicide (IPTS) has been widely studied in adults, but not adolescent populations at acute risk for suicide. Accordingly, this study aimed to evaluate IPTS clinical utility in a high-risk sample of suicidal adolescent inpatients. We assessed whether constructs of the IPTS (1) are associated with suicidal thoughts and behaviors (STBs) on admission to a psychiatric hospitalization, and (2) prospectively predict suicide attempt (SA) or psychiatric rehospitalization 90 days after discharge. On admission, adolescent patients self-reported recent STBs, perceived burdensomeness (PB), thwarted belongingness (TB), and depression. Parents reported their child's rehospitalization and suicide attempts 90 days after discharge. Generalized linear regression modelling was used to determine how key constructs of the IPTS are associated with STBs prior to admission and whether they prospectively predict SA or rehospitalization 90 days after discharge. IPTS constructs did not predict rehospitalization or SA within 90 days of discharge. Although PB and TB interacted to associate with prehospitalization SI frequency, and PB, TB and NSSI interacted to associate with prehospitalization SA, the nature of these interactions were not as the IPTS predicts. IPTS constructs are relevant proximal predictors of rehospitalization STB in adolescents, but may operate differently than in adults.

1. Introduction

Suicide is the second leading cause of death in adolescents, and the suicide death rate has risen in the US in all age groups between 2000 and 2016 (Centers for Disease Control and Prevention, 2017; Hedegaard et al., 2018). For many adolescents, severe episodes of suicidal thoughts or behaviors (STB) result in inpatient hospitalization for crisis stabilization and psychiatric care. Psychiatric hospitalization, an objective marker of acute psychiatric crisis, is a significant disruption for youth and their families. The three months following discharge are among the highest risk periods for suicidal behaviors and/or psychiatric crisis requiring rehospitalization in adolescents (Fontanella, 2008; Prinstein et al., 2008). Unfortunately, we have limited understanding of the psychological constructs that account for STB risk, psychiatric crisis and the subsequent need for psychiatric hospitalization among youth. A better understanding of these constructs could help to identify patients

at risk, lead to treatment targets during hospitalization, and ultimately reduce the need for rehospitalization. Thus, it is crucial that we develop ways to identify youth most likely to attempt suicide or be hospitalized for high-risk STB.

The interpersonal-psychological theory of suicide (IPTS) attempts to explain the emergence of suicidal ideation (SI) and suicide attempt (SA) and, thus, provides constructs that may influence STBs that increase risk for psychiatric hospitalization. The IPTS hypothesizes that the constructs *thwarted belongingness* (TB; the perception that one does not belong in valued social groups), and *perceived burdensomeness* (PB; the perception that one is a burden to friends and family) interact to increase the *desire to die* or SI. The theory further hypothesizes that *acquired capability* (AC; an undermined self-preservation instinct) interacts with SI to result in SA (Van Orden et al., 2010).

Although not without critics (Hjelmeland and Knizek, 2019), the IPTS may be useful for clinicians trying to predict risk, intervene and

* Corresponding author.

E-mail addresses: cking@mclean.harvard.edu (C.D. King), vjoyce@franciscanchildrens.org (V.W. Joyce), evan.kleiman@rutgers.edu (E.M. Kleiman), rbonopane@franciscanchildrens.org (R.J. Buonopane), amillner@fas.harvard.edu (A.J. Millner), cnash@franciscanchildrens.org (C.C. Nash).

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prevent negative clinical outcomes like SA and rehospitalization particularly for adolescents hospitalized for STB. In fact, a recent review of studies using proxies or constructs closely related to the IPTS indicated preliminary support for the theory in adolescents (Stewart et al., 2017). However, studies that investigate the IPTS in adolescents are scarce. For example, a meta-analysis (Chu et al., 2017) of 122 IPTS studies identified only four studies of adolescents that met inclusion criteria for the study. Notably, the effect sizes of IPTS constructs in this meta-analysis were minimal to moderate, comparable to other established predictors of STB, and statistically significant. The meta-analysis generally found support for IPTS hypotheses, but highlighted the need to study the theory in younger populations (Chu et al., 2017).

The few adolescent studies that explicitly test the IPTS provide mixed support for its hypotheses and its utility in clinical adolescents. Studies of clinical and general adolescent samples have generally found cross-sectional associations between STBs and IPTS constructs (Barzilay et al., 2015; Horton et al., 2016; King et al., 2017; Miller et al., 2016; Opperman et al., 2015; Podlogar et al., 2017). PB is frequently associated with STBs whereas associations between TB and STBs are weak or are only found with respect to family TB and not peer TB (in the one study that measured family vs. peer TB; Opperman et al., 2015). Additionally, nearly all cross-sectional studies fail to find that TB and PB interactions or that TB, PB and AC interactions are associated with STB as the IPTS posits (Barzilay et al., 2015; Horton et al., 2016; Opperman et al., 2015; Podlogar et al., 2017).

The few extant longitudinal studies of IPTS constructs and STBs in adolescents generally find that TB and PB have limited predictive utility over longer timeframes (Czyz et al., 2014; King et al., 2017; Miller et al., 2016). However, it is unclear whether this is due to study limitations. One longitudinal inpatient study found that PB measured at admission was significantly associated with SI at admission but not at time of discharge, and it found no association between TB and SI, or a PB and TB interaction (Miller et al., 2016). Another study of adolescents in an intensive outpatient program similarly found that PB and TB measured at admission were not associated with suicide risk at discharge (King et al., 2017). Only one study has tested whether IPTS constructs prospectively predict SA in adolescents following hospital discharge. This study found no evidence (1) that PB and TB prospectively predict SA on their own, (2) that they interact to predict SA or (3) that PB, TB and AC interact to prospectively predict SA. However, this study did not utilize validated measures of PB and TB (Czyz et al., 2014), providing motivation for research that does. Notably, prospective studies of any STB predictors generally do not find that single constructs measured at one timepoint explain substantial variation of STBs at significantly later timepoints. For example, Franklin and colleagues (2016) conducted a recent meta-analysis of the prior 50 years of long-term predictive STB studies (Franklin et al., 2017). Among the 365 studies in the meta-analysis with an average study length of 10 years, they found that individual predictors of STB were only slightly better than chance. This has motivated recent studies pursuing STB prediction on the order of hours and days instead of months and years (Czyz et al., 2019; Kleiman et al., 2017; Kyron et al., 2018; Ribeiro et al., 2019; Rogers and Joiner, 2019).

Despite this trend in the field, it is notable that only 4.37% of studies in the Franklin and colleagues (2016) meta-analysis featured a study length of 0 to 6 months (Franklin et al., 2017). For clinical populations, this understudied time frame is the most high-risk in the months following psychiatric discharge (Fontanella, 2008; Prinstein et al., 2008). Determination of post-hospitalization STB risk is an important objective for clinicians in psychiatric acute care settings. Identification of post-hospitalization risk factors could identify treatment targets during hospitalization that improve care and reduce negative post-discharge outcomes. IPTS constructs may be especially applicable to post-hospitalization risk, given their theorized relationship to STB. Although these constructs are responsive to intensive treatment (King et al., 2017; Miller et al., 2016), levels of these constructs may revert to

prehospitalization levels when adolescents are discharged to their prehospitalization environment.

Unfortunately, to date, only one study has examined whether IPTS constructs predict post-hospitalization SA after discharge from an inpatient psychiatric unit and no studies have examined rehospitalization. Although the IPTS makes no claims regarding psychiatric rehospitalization, this is a significant gap, as investigating the relationship between IPTS constructs and rehospitalization may lead to interventions that improve concrete clinical outcomes, thereby reducing a significant burden for adolescents and their families.

To further establish that IPTS constructs are superior predictors of risk, they must explain STB variance above and beyond well-characterized and validated risk factors for STB, such as depression. Interestingly, when some prior studies in this area have controlled for depression severity, IPTS constructs, particularly TB, are no longer significant predictors of STB, suggesting that depression accounts for overlapping STB variance with IPTS constructs (Barzilay et al., 2015; Horton et al., 2016; Mbroh et al., 2018; Miller et al., 2016; Podlogar et al., 2017). Notably, some of these studies do not use validated measures of IPTS constructs. Additionally, at least one other study has found that the interaction of PB*TB measured at exit from an intensive outpatient program explains significant concurrent suicide risk above and beyond depression (King et al., 2017).

Considering prior mixed support for the IPTS in different adolescent populations, it is unclear whether the IPTS has clinical utility in adolescent psychiatric inpatient populations. Of extant adolescent IPTS studies, four have investigated psychiatric samples (Czyz et al., 2014; Horton et al., 2016; King et al., 2017; Miller et al., 2016); only one prospectively tracked patients after discharge (Czyz et al., 2014); only one predicted negative clinical outcomes such as suicidal behaviors (Czyz et al., 2014); and only four used validated measures of both PB and TB (Horton et al., 2016; King et al., 2017; Mbroh et al., 2018; Miller et al., 2016). Importantly, there is no single IPTS study to our knowledge that has all four of these features, and none attempt to predict rehospitalization. To test IPTS clinical utility, the current study sought to include all of these characteristics. The main goals of the current study were to:

- (1) Test the association between SI and PB or TB assessed retrospectively on admission to a pediatric psychiatric hospital.
- (2) Test the association between SA and interaction of PB, TB, and NSSI (proxy for AC) assessed retrospectively on admission to a pediatric psychiatric hospital.
- (3) Test the prospective relationship between SA and rehospitalization (as an exploratory aim) within 90 days after hospital discharge and PB, TB and NSSI (proxy for AC) assessed retrospectively on admission.
- (4) To compare models testing these associations and controlling for depression severity with similar models that omitted depression altogether.

2. Methods

2.1. Participants

The study was approved by the study site institutional review board. Patient-reported data were collected on standardized clinical assessments administered to all patients ages 12–19 ($n = 724$) consecutively admitted to the acute inpatient pediatric psychiatric unit between September 2016 and October 2018 at a hospital in a large northeastern metropolitan area. Beginning in June of 2017, as part of a standard clinical outcomes process, patients' parents ($n = 428$) were emailed 90-day post-hospitalization surveys assessing whether their children had experienced several negative outcomes (e.g., SA, rehospitalization) since discharge. The response rate for these post-hospitalization parent surveys was 50% ($n = 214$). Demographic and clinical admission

Table 1
Characteristics of study sample by follow up survey completion status.

	No Response <i>n</i> = 214		mean	Response <i>n</i> = 214		mean	<i>t</i> or <i>X</i> ²	<i>p</i>
	<i>n</i>	%		<i>n</i>	%			
Demographic Characteristics								
Age			16.03			16.09	−0.41	0.684
Female	144	67.3%		149	69.6%		0.17	0.677
Male	70	32.7%		65	30.4%		0.17	0.677
Identify as Trans	9	4.2%		6	2.8%		2.61	0.272
Adopted	17	7.9%		20	9.3%		1.26	0.532
Asian or Asian American	26	12.1%		17	7.9%		1.65	0.198
Black or African American	10	4.7%		6	2.8%		0.58	0.445
Hispanic	15	7.0%		15	7.0%		0.00	1.000
Native American	0	0.0%		1	0.5%		0.00	1.000
Native Hawaiian or Pacific Islander	0	0.0%		0	0.0%		0.00	1.000
White	157	73.4%		158	73.8%		0.00	1.000
Other	8	3.7%		5	2.3%		0.32	0.573
Race/ethnicity not documented	7	3.3%		19	8.9%		4.95	0.026
Clinical Characteristics								
Length of Stay			16.10			16.01	0.04	0.965
Prior Hospitalizations			1.01			1.08	−0.40	0.704
Admitted for Self Harm	170/183	92.8%		160/169	94.6%			
SI Days in week before admission			2.79			2.81	−0.08	0.940
NSSI in week before admission			1.08			0.98	0.47	0.637
SA in month before admission			0.40			0.44	−0.49	0.622
CESD-C Score			35.22			34.72	0.35	0.730
INQ Thwarted Belongingness			31.31			32.76	−1.09	0.275
INQ Perceived Burdensomeness			18.80			18.92	−0.11	0.915

characteristics were collected for the 428 patients whose parents completed the first part of the clinical outcomes process. As presented in Table 1, there were no significant clinical or demographic differences between parents who responded and parents who did not respond to the survey at 90 days after discharge except for parents of children whose race/ethnicity was not documented ($t = 4.95$, $p < 0.026$). Of the 214 parents who responded to the follow up survey, 19% ($n = 41$) reported that their child was rehospitalized, and 10% ($n = 21$)% reported that their child had attempted suicide.

Among all patients ($n = 724$), 70% ($n = 510$) had some prior week SI, 65% ($n = 470$) had at least one instance NSSI in their lifetime, and 46% ($n = 334$) had at least one lifetime SA. Of 428 patients with demographic and clinical admission data, 68% were female, 74% were Caucasian, 9% were adopted, and 94% were admitted for self-harm as determined by a psychiatrist at admission. Patients had a mean of 1 previous psychiatric hospitalization, the mean patient age was 16 years, and patients had a mean length of stay of 16 days.

2.2. Measures

As part of standard intake assessment, participants completed the following surveys within two days of admission to the pediatric psychiatric inpatient unit:

- (1) Interpersonal Needs Questionnaire (INQ) 15 item version - A validated self-report measure of six questions assessing PB and nine questions assessing TB with excellent internal consistency (PB $\alpha = 0.95$; TB $\alpha = 0.89$) in our sample (Hill et al., 2015; Van Orden et al., 2012).
- (2) Self-Injurious Thoughts and Behaviors Interview Self-Report Version (SITBI) - a self-report measure of a patient's self-injurious thoughts, plans, and attempts over the individual's lifetime, past year, past month, and past week (Nock et al., 2007). For this analysis we examined past week SI, and past month SA as outcomes, and following previous studies we used lifetime NSSI count as a proxy for AC (Barzilay et al., 2015; Christensen et al., 2013; Klonsky et al., 2013; Nock et al., 2006; Prinstein et al., 2008).
- (3) Center for Epidemiological Studies Depression Scale for Children

(CES-DC) - a 20 item self-report measure of depression in children with excellent internal consistency ($\alpha = 0.94$) in our sample (Faulstich et al., 1986).

Additionally, parents that completed the 90-day post-discharge survey responded to two questions regarding whether their child had been readmitted to an inpatient psychiatric hospital or attempted suicide in the three months since hospital discharge.

2.3. Statistical analysis

Prior to analysis responses to the SI item were capped at the maximum of seven days, affecting 15 observations. The SA variable was winsorized at the 99th percentile to reduce the impact of outliers in subsequent modelling, affecting 6 observations. All independent variables (TB, PB, CES-DC) were calculated according to published scoring documentation, and were standardized and centered at the mean (Hill et al., 2015; Weissman et al., 1980).

All SITBI dependent variables (SI, SA, NSSI) clearly displayed a zero-inflated (i.e., more zeros than would be expected in a typical count distribution) truncated negative binomial distribution characteristic of right censored count data. SA frequency distribution featured a negligible right truncation artificially induced by winsorizing, but SI distribution naturally displayed a truncated distribution. A visual display of the SI and SA distributions can be found in Fig. 1, in addition to distributions of PB and TB. As Cukrowicz et al. (2013) and Chu et al. (2017) have noted, few previous studies of the IPTS appropriately model STB count outcomes according to their distributions (Chu et al., 2017; Cukrowicz et al., 2013). This may result in incorrect model statistics and undermine the accuracy of results. Consequently, truncated negative binomial generalized linear hurdle regression models were used in subsequent regression modeling featuring SITBI variables as an outcome. To address zero inflation, hurdle regression models were chosen to model a possible thresholding effect present in the STB manifestation process (i.e. once an individual experiences a STB, they cross a threshold above which a different process determines the STB frequency). Hurdle regression models deal with the problem of zero-inflated outcome distributions by modelling the generation of zero

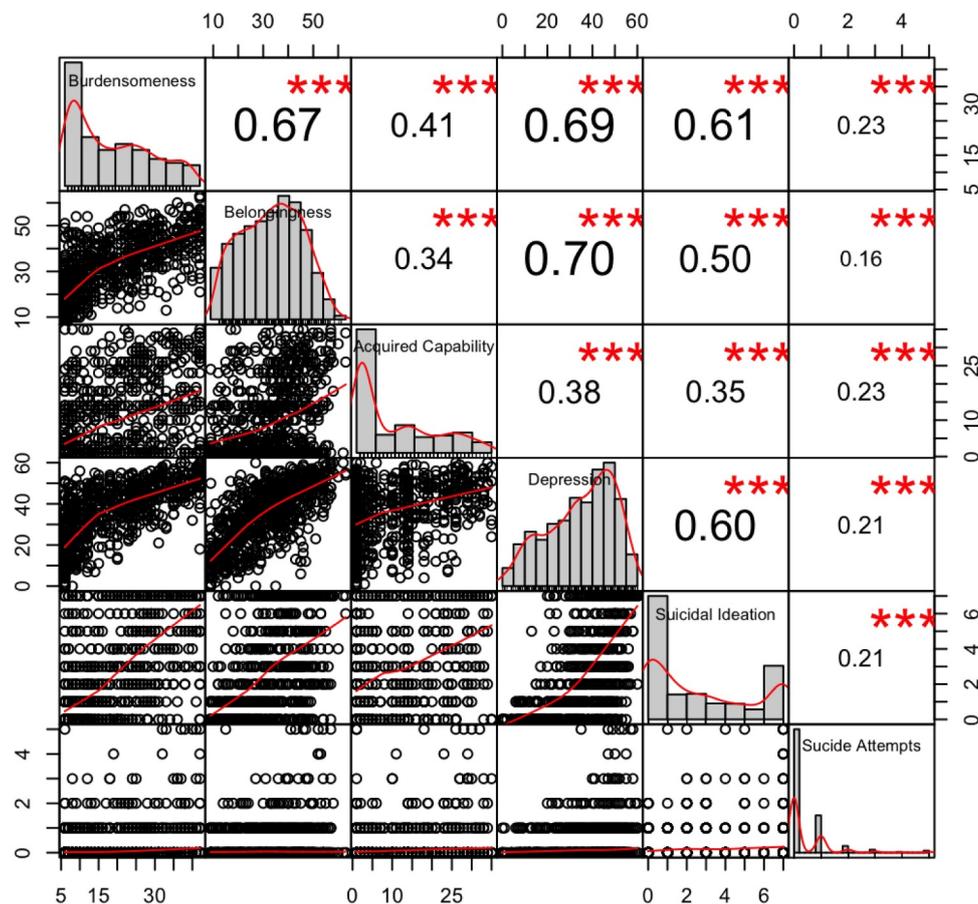


Fig. 1. Visual Correlation matrix of independent and dependent variables.

and non-zero count values as two distinct processes (Mullahy, 1986). Thus, one binomial model is aimed at predicting a zero vs. non-zero count (presence model). Secondly, among those with a non-zero count value, a generalized linear model predicts count frequencies according to a count distribution (frequency model). These models used in this analysis estimate an incident rate of a dependent variable by calculating an incidence rate ratio (IRR) for independent variables. IRRs in such models are similar to odds ratios, and equal the incident rate at a given value of an independent variable divided by the incident rate at a one unit increase in the independent variable. In frequency models, IRR values above 1 indicate positive association; in presence models, IRR values below 1 indicate positive association. For prospective prediction models in this study, logistic regression models were used to predict the occurrence of any SA and any rehospitalization in the 90 days after discharge, because these two variables are binary.

We focused on testing the association between TB and PB and NSSI with four different outcomes: SI prior to admission, SA prior to admission, SA within 90 days of discharge, rehospitalization within 90 days of discharge. We tested each outcome with a series of four sequential models. Model 1 included TB and PB as independent variables; Model 2 was identical to Model 1 but controlled for depression severity; Model 3 included TB and PB as independent variables with an interaction term of TB and PB; and finally Model 4 was identical to Model 3 but controlled for depression severity. The IPTS also hypothesizes that suicide attempts are driven by TB, PB and AC. We therefore constructed two additional models when testing suicide attempts (at admission and prospectively post-discharge), and rehospitalization. Model 5 included TB, PB, their interaction and an interaction term of TB, PB and NSSI (proxy for AC). Model 6 was identical to Model 5 but controlled for depression. Akaike information criterion (AIC) were used to

comparatively select the best fitting model in each series. Only the model with the best fit of each series is presented and interpreted in the results section below. Models without statistically significant interaction terms were not selected for interpretation. However, we provide all models in Tables 2, 3, 4, and 5.

All analyses were conducted in R 3.5.2. All generalized linear models were modeled with the R package 'glmmTMB' version 0.2.3 (Brooks et al., 2017). Tests of model specification were performed using the R package 'DHARMa' version 0.2.1 (Hartig, 2019). The DHARMa package implements diagnostic tests for model misspecification like residual overdispersion or zero-inflation which are common in regression models with count distribution. These tests failed to suggest that any of our models were misspecified. We also tested the identical series of models with Poisson and negative binomial regression models modeled with and without zero inflation. Diagnostic tests of these other models consistently identified residual overdispersion and zero-inflation, allowing us to conclude that truncated negative binomial generalized linear hurdle regression models provided the most optimal residual distributions.

Lastly, we conducted a power analysis for each outcome using G*Power 3 (Faul et al., 2007). All power analyses assumed an alpha level of 0.05 and calculated the effects size detectable at 80% power. For prehospitalization SI and SA models featuring two-part hurdle models, power was calculated separately for each part of the hurdle model. Power analyses revealed that the binomial models of the SI and SA model series would detect an odds ratio of 1.26 power given $n = 724$, and the frequency model would detect an IRR of 1.06–1.17. Prospective rehospitalization post-hospitalization SA models could expect to detect an odds ratio of 1.55–1.74.

Table 2
Association of perceived burdensomeness and thwarted belongingness with days of suicidal ideation in week prior to hospitalization (n = 724).

Predictors	Model 1			Model 2			Model 3			Model 4		
	Incidence Rate Ratios	CI	Statistic p	Incidence Rate Ratios	CI	Statistic p	Incidence Rate Ratios	CI	Statistic p	Incidence Rate Ratios	CI	Statistic p
Frequency Model												
Thwarted Belongingness	1.16	1.07 – 1.25	3.69 <0.001	1.07	0.98 – 1.16	1.58 0.113	1.23	1.13 – 1.33	5.00 <0.001	1.14	1.05 – 1.24	2.98 0.003
Perceived Burdensomeness	1.30	1.21 – 1.40	7.43 <0.001	1.20	1.12 – 1.30	4.88 <0.001	1.37	1.28 – 1.48	8.73 <0.001	1.27	1.18 – 1.37	6.12 <0.001
CESD-C				1.29	1.16 – 1.44	4.76 <0.001				1.27	1.14 – 1.41	4.45 <0.001
TB*PB							0.87	0.82 – 0.93	-4.22 <0.001	0.88	0.83 – 0.94	-3.89 <0.001
Presence Model												
Thwarted Belongingness	0.72	0.57 – 0.92	-2.59 0.009	1.16	0.87 – 1.54	0.98 0.328	0.74	0.53 – 1.01	-1.89 0.059	1.09	0.77 – 1.53	0.47 0.638
Perceived Burdensomeness	0.28	0.20 – 0.39	-7.62 <0.001	0.45	0.32 – 0.64	-4.48 <0.001	0.28	0.20 – 0.39	-7.48 <0.001	0.46	0.33 – 0.66	-4.28 <0.001
CESD-C				0.33	0.24 – 0.44	-7.29 <0.001				0.33	0.24 – 0.44	-7.32 <0.001
TB*PB							1.02	0.75 – 1.40	0.15 0.884	0.90	0.65 – 1.25	-0.64 0.522
AIC	2786.721			2706.123			2772.429			2694.156		

3. Results

Table 2 displays the results of the model series testing the association between SI in the week prior to hospitalization and TB and PB. We find that Model 4 has the best fit of all models (AIC = 2694.2). This model tests for an interaction between TB and PB when controlling for depression. In model 4, TB and PB do not interact to associate with the presence of SI (IRR = 0.90, CI = 0.65–1.25, Z = -0.64, p = 0=.552). However, among those with SI, TB and PB interact to associate with the frequency of SI (IRR = 0.88, CI = 0.83–0.94, Z = -3.89, p < 0.001). In model 4, depression remains a significant predictor of both presence and frequency of SI (presence: IRR = 0.33, CI = 0.24–0.44, Z = -7.32, p < 0.001; frequency: IRR:1.27, CI:1.14–1.41, Z = 4.45, p < 0.001). As Fig. 2 illustrates, individuals with high PB are at elevated risk of SI, regardless of their level of TB. However, among individuals with lower levels of PB, a one unit increase in TB is associated with a greater increase in SI frequency than those with higher levels of PB.

Table 3 displays the results of the model series testing the association between SA in the month prior to hospitalization and lifetime NSSI as a proxy for AC, TB and PB. In Model 3 and Model 4, we find no evidence of a two-way interaction between PB and TB when modeled without NSSI. As Model 6 shows, we do find evidence of a three-way interaction between NSSI, PB and TB (IRR:0.96, CI:0.93–1.00, Z = -2.27, p < 0.023). Model 6, which includes the three-way interaction between NSSI, PB, TB, and controls for depression has the best fit of all models (AIC = 182.71). The PB*TB*NSSI interaction is visualized in Fig. 3. Notably, the highest frequency of SA in the month prior to admission is associated with the highest levels of PB and NSSI, and the lowest levels of TB.

Table 4 displays the results of modelling TB, PB and NSSI as predictors of SA in the 90 days after discharge from a pediatric psychiatric hospitalization. No models in this series find that TB, PB or NSSI individually predict, or interact to predict suicide attempt in the 90 days after discharge.

Table 5 displays the results of modelling TB, PB and NSSI as predictors of rehospitalization in the 90 days after discharge from a pediatric psychiatric hospitalization. No models in this series find that TB, PB or NSSI individually predict, or interact to predict rehospitalization in the 90 days after discharge.

4. Discussion

The current study tested the association between IPTS variables (PB, TB and AC via NSSI as a proxy) and pre- and post-hospitalization STB and rehospitalization among adolescents on an inpatient psychiatric unit. We identified significant interactions between IPTS variables prior to admission. However, the nature of these interactions is not as the IPTS would predict. TB and PB interacted to associate with SI frequency, however, the highest frequency of SI did not occur only at the highest levels of PB and TB. TB, PB, and NSSI also interacted to associate with SA, however, the highest frequency of SA occurred at the highest levels of PB and NSSI, and the lowest levels of TB. Without modelling interactions, PB and, to some extent, TB were significantly associated with SI and SA prior to admission but did not predict SA and rehospitalization 90 days after discharge. Thus, the main takeaway of this study is that IPTS constructs may be clinically relevant and important factors related to STB in adolescents recently admitted to inpatient psychiatric care, but when measured on admission, have limited clinical utility in predicting SA or rehospitalization after discharge. Below we discuss the clinical and research implications for each variable and interpret our findings in the context of the IPTS.

The finding that PB stands out among IPTS constructs as a significant predictor of STB without accounting for interactions with other variables is consistent with several other studies among both adults and adolescents, and among clinical and non-clinical samples (Horton et al., 2016; Ma et al., 2016; Miller et al., 2016). Given that PB is related to SI

Table 3
Association of perceived burdensomeness, thwarted belongingness and NSSI with number of suicide attempts in month prior to hospitalization (n = 724).

Predictors	Model 1 Incidence Rate Ratios			Model 2 Incidence Rate Ratios			Model 3 Incidence Rate Ratios			Model 4 Incidence Rate Ratios		
	CI	Statistic	p	CI	Statistic	p	CI	Statistic	p	CI	Statistic	p
Frequency Model												
Thwarted Belongingness	1.93	1.21 – 3.07	0.006	1.53	0.94 – 2.49	0.090	1.90	1.18 – 3.04	0.008	1.46	2.66	0.008
Perceived Burdensomeness	1.17	0.78 – 1.78	0.447	0.91	0.58 – 1.44	0.695	1.10	0.70 – 1.74	0.666	0.82	0.43	0.666
CESD-C				2.17	1.13 – 4.15	0.020				2.27	0.69	0.492
TB*PB							1.13	0.80 – 1.59		1.20		
NSSI												
TB*NSSI												
PB*NSSI												
TB*PB*NSSI												
Presence Model												
Thwarted Belongingness	1.19	0.95 – 1.49	0.125	1.37	1.06 – 1.76	0.016	1.18	0.94 – 1.49	0.147	1.38	1.45	0.147
Perceived Burdensomeness	0.61	0.49 – 0.76	<0.001	0.69	0.54 – 0.88	0.003	0.63	0.50 – 0.79	<0.001	0.73	-3.95	<0.001
CESD-C				0.73	0.56 – 0.94	0.017				0.70	-1.12	0.264
TB*PB							0.91	0.76 – 1.08		0.86		
NSSI												
TB*NSSI												
PB*NSSI												
TB*PB*NSSI												
AIC	1196.585			1188.787			1188.853			1189.110		
Model 5												
Model 6												
Model 4												
Predictors	CI	Statistic	p	CI	Statistic	p	CI	Statistic	p	CI	Statistic	p
Frequency Model												
Thwarted Belongingness	0.88 – 2.40	1.48	0.140	3.25	1.46 – 7.27	0.004	2.49	1.10 – 5.63	0.028	2.20	2.20	0.028
Perceived Burdensomeness	0.50 – 1.35	-0.78	0.434	0.41	0.17 – 1.01	0.054	0.30	0.12 – 0.75	0.010	-2.58	-2.58	0.010
CESD-C	1.18 – 4.40	2.44	0.015				2.22	1.21 – 4.10	0.011	2.56	2.56	0.011
TB*PB	0.85 – 1.71	1.04	0.297	2.01	1.10 – 3.66	0.023	2.16	1.19 – 3.90	0.011	2.54	2.54	0.011
NSSI				1.04	1.00 – 1.09	0.049	1.04	1.00 – 1.08	0.071	1.80	1.80	0.071
TB*NSSI				0.98	0.93 – 1.02	0.298	0.98	0.93 – 1.02	0.353	-0.93	-0.93	0.353
PB*NSSI				1.06	1.01 – 1.11	0.024	1.06	1.01 – 1.11	0.016	2.42	2.42	0.016
TB*PB*NSSI				0.97	0.94 – 1.00	0.033	0.96	0.93 – 1.00	0.023	-2.27	-2.27	0.023
Presence Model												
Thwarted Belongingness	1.06 – 1.78	2.43	0.015	1.30	0.93 – 1.82	0.130	1.50	1.04 – 2.17	0.029	2.19	2.19	0.029
Perceived Burdensomeness	0.57 – 0.95	-2.39	0.017	0.67	0.48 – 0.95	0.022	0.77	0.54 – 1.11	0.164	-1.39	-1.39	0.164
CESD-C	0.53 – 0.91	-2.63	0.009				0.72	0.55 – 0.95	0.021	-2.30	-2.30	0.021
TB*PB	0.72 – 1.03	-1.59	0.111	0.86	0.66 – 1.12	0.266	0.82	0.63 – 1.08	0.160	-1.41	-1.41	0.160
NSSI				0.97	0.95 – 0.99	0.001	0.97	0.95 – 0.99	0.003	-2.96	-2.96	0.003
TB*NSSI				0.99	0.97 – 1.02	0.587	0.99	0.97 – 1.02	0.501	-0.67	-0.67	0.501
PB*NSSI				1.00	0.98 – 1.02	0.911	1.00	0.98 – 1.02	0.999	0.00	0.00	0.999
TB*PB*NSSI				1.01	0.99 – 1.02	0.421	1.01	0.99 – 1.02	0.366	0.90	0.90	0.366
AIC	1191.298			1182.706			1182.706					

Table 4
Perceived burdensomeness, thwarted belongingness and NSSI predicting suicide attempt within 90 days after discharge (*n* = 2112).

Predictors	Model 1			Model 2			Model 3			Model 4		
	Odds Ratios	CI	Statistic	<i>p</i>	Odds Ratios	CI	Statistic	<i>p</i>	Odds Ratios	CI	Statistic	<i>p</i>
Thwarted Belongingness	1.01	0.96 – 1.06	0.33	0.744	0.99	0.93 – 1.04	-0.45	0.654	0.98	0.91 – 1.06	-0.53	0.595
Perceived Burdensomeness	1.04	0.98 – 1.10	1.34	0.179	1.01	0.96 – 1.08	0.48	0.632	0.97	0.84 – 1.13	-0.35	0.728
CESD-C					1.05	0.99 – 1.12	1.79	0.074				
TB*PB									1.00	1.00 – 1.00	0.95	0.342
NSSI												
TB*NSSI												
PB*NSSI												
TB*PB*NSSI												
Tjur's R ²	0.027				0.037				0.033			0.049
AIC	133.286				131.897				134.384			132.049

Predictors	Model 4			Model 5			Model 6				
	CI	Statistic	<i>p</i>	Odds Ratios	CI	Statistic	<i>p</i>	Odds Ratios	CI	Statistic	<i>p</i>
Thwarted Belongingness	0.86 – 1.03	-1.33	0.182	0.90	0.79 – 1.04	-1.40	0.162	0.85	0.73 – 1.00	-1.93	0.054
Perceived Burdensomeness	0.78 – 1.08	-1.04	0.299	1.05	0.83 – 1.32	0.39	0.694	0.96	0.75 – 1.23	-0.31	0.760
CESD-C	1.00 – 1.13	2.01	0.045					1.07	1.00 – 1.14	1.97	0.049
TB*PB	1.00 – 1.01	1.35	0.177	1.00	1.00 – 1.01	0.96	0.337	1.00	1.00 – 1.01	1.41	0.157
NSSI				1.09	0.86 – 1.38	0.68	0.496	1.06	0.82 – 1.36	0.43	0.666
TB*NSSI				1.00	1.00 – 1.01	0.82	0.413	1.00	1.00 – 1.01	0.96	0.337
PB*NSSI				0.99	0.98 – 1.01	-1.02	0.308	0.99	0.98 – 1.01	-0.81	0.415
TB*PB*NSSI				1.00	1.00 – 1.00	-0.04	0.971	1.00	1.00 – 1.00	-0.25	0.802
Tjur's R ²				0.073				0.089			
AIC				134.527				132.374			

Table 5
Perceived burdensomeness, thwarted belongingness and NSSI predicting rehospitalization within 90 days after discharge (n = 212).

Predictors	Model 1			Model 2			Model 3			Model 4		
	CI	Statistic	p									
Thwarted Belongingness	0.98 – 1.06	1.05	0.292	0.98 – 1.06	0.98	0.327	0.96 – 1.08	0.56	0.573	0.96 – 1.08	0.56	0.573
Perceived Burdensomeness	0.98 – 1.06	0.85	0.397	0.97 – 1.07	0.79	0.431	0.90 – 1.13	0.17	0.863	0.90 – 1.13	0.17	0.863
CESD-C				0.96 – 1.04	-0.05	0.960						
TB*PB							1.00 – 1.00	0.15	0.879	1.00 – 1.00	0.15	0.879
NSSI												
TB*NSSI												
PB*NSSI												
TB*PB*NSSI												
Tjur's R ²	0.031			0.031			0.031			0.031		
AIC	204.984			206.982			206.961			208.960		

Predictors	Model 4			Model 5			Model 6		
	CI	Statistic	p	CI	Statistic	p	CI	Statistic	p
Thwarted Belongingness	0.96 – 1.08	0.53	0.596	0.92 – 1.08	-0.03	0.972	0.92 – 1.09	0.01	0.996
Perceived Burdensomeness	0.90 – 1.14	0.17	0.863	0.75 – 1.13	-0.81	0.418	0.75 – 1.14	-0.76	0.445
CESD-C	0.96 – 1.04	-0.03	0.978				0.96 – 1.04	-0.13	0.896
TB*PB	1.00 – 1.00	0.15	0.884	1.00 – 1.01	1.00	0.319	1.00 – 1.01	0.97	0.330
NSSI				0.85 – 1.24	0.27	0.787	0.85 – 1.25	0.28	0.779
TB*NSSI				0.99 – 1.01	0.06	0.956	0.99 – 1.01	0.05	0.959
PB*NSSI				0.99 – 1.01	0.76	0.447	0.99 – 1.01	0.75	0.455
TB*PB*NSSI				1.00 – 1.00	-0.81	0.417	1.00 – 1.00	-0.80	0.422
Tjur's R ²									
AIC				211.165			213.148		

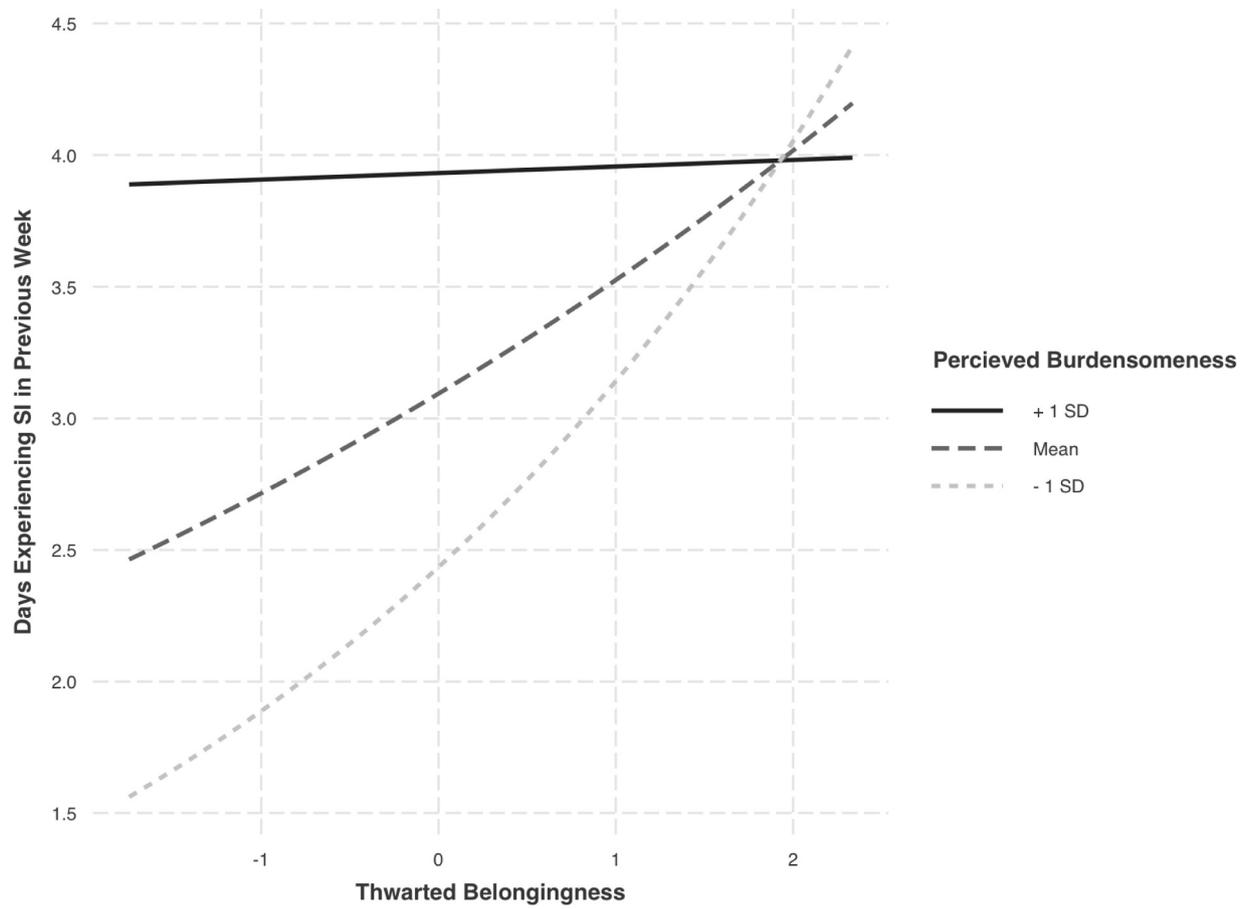


Fig. 2. Perceived burdensomeness and thwarted belongingness predicting number of days experiencing SI.

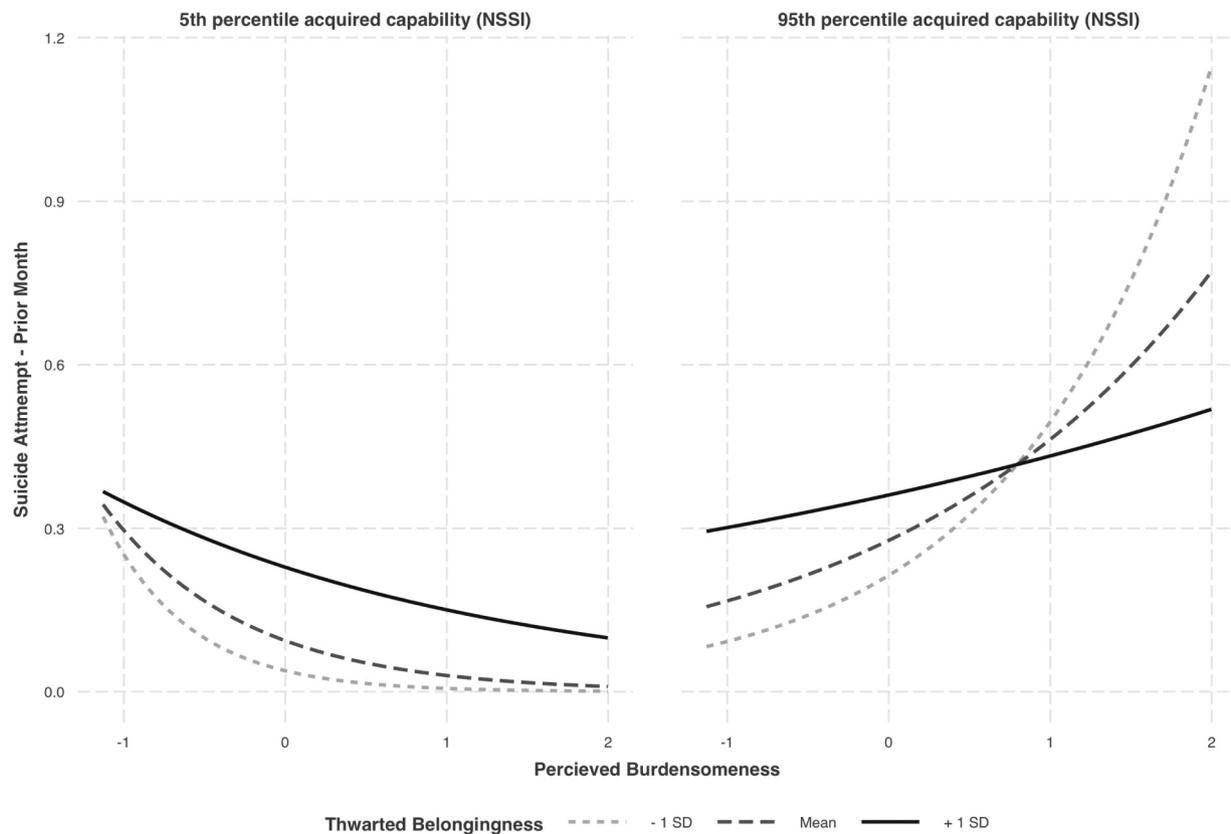


Fig. 3. Interaction effects of perceived burdensomeness, thwarted belongingness, and acquired capability predicting number of SAs in prior month.

and SA independent of depression symptoms, these results suggest that PB could be an important target for treatment, especially to supplement treatments that are already targeting depression. Future work should investigate the nuances of how PB operates in an adolescent population. While study results regarding the clinical utility of PB with regard to STB in this population are encouraging, findings regarding TB are less so. Given its weaker relationships with SI and SA especially when controlling for depression, TB appears less clinically relevant in this population when not accounting for interactions with other variables.

We find TB and PB interact to associate with frequency of SI in the week prior to admission. Additionally, we find that this interaction, while statistically significant, features an important nuance. Our modelling suggests that increasing TB is only associated with substantial additional SI frequency at low to moderate levels of PB. At levels of high PB, the frequency of SI remains elevated and relatively stable on average across all levels of TB. Thus, TB seems to only matter with regards to SI frequency when PB is not already elevated. This interaction also indicates that distinct combinations of TB and PB levels may underlie similar presentations of SI frequency. If SI is causally downstream from TB and PB as the IPTS theory would suggest, our results indicate that interventions to reduce SI by targeting high burdenedness may only be effective if TB is low or if high TB is also targeted for treatment. Likewise, interventions targeting high thwarted belongingness may only be effective for patients with already low burdenedness. This is contrary to a more simplistic interaction whereby any reduction in PB or TB is associated with some reduction in SI. At least two studies have attempted to measure the responsiveness of PB and TB to intervention. One study found that while an intervention targeting PB in adolescents successfully lowered PB, reductions in PB were not associated with reductions in a suicide risk score (Hill and Pettit, 2019). Our study suggests this may be due to lack of an intervention also targeting TB. Another study found that during an outpatient suicide prevention program, reductions in both TB and PB were associated with reductions in suicide risk (Hains et al., 2019). Notably, one recent study measuring these constructs in adolescents after hospital discharge has identified a TP*PB interaction in the expected direction (Czyz et al., 2019), indicating that our interaction results may reflect effects of measurement timing. It may be that TB and PB relate to SI differently when hospitalized. Future clinical research should target these constructs with interventions to test whether and how they interact to effect STB. Future work should also investigate the nature of this interaction and model count outcomes optimally so that findings regarding interactions are not influenced by model misspecification.

We also find that NSSI (as a proxy for AC) interacts with TB and PB to associate with the frequency of SA. However, the nature of this interaction is not as the IPTS predicts. Our modelling suggests that at low levels of NSSI in the population, increases in PB are associated with decreases in SA. At high levels of NSSI in the population, increases in PB are associated with increases in SA, and the greatest increases are found in those with low TB. Indeed, the highest frequency of prior month SA is found in those with high NSSI, high PB and low TB. This finding does not align with the IPTS prediction that SA occurs at the highest levels of TB, PB and AC. These findings may suggest that while IPTS constructs are applicable to adolescent STBs, IPTS constructs may operate differently in adolescent populations than the theory predicts. However, it is important to note that our measurement of NSSI may be an imperfect proxy for acquired capability.

Interestingly, IPTS variables measured at admission perform less well as predictors of SA within 90 days after discharge. While it is important to note that the 50% response rate may indicate response bias, we find no evidence that IPTS constructs predict SA. This aligns with Miller et al. (2016) findings that IPTS variables measured at entry to a partial hospitalization program were associated with SI at entry to but not exit from the program (Miller et al., 2016). This marked difference in cross-sectional and prospective outcomes does not necessarily rule out the clinical utility of IPTS variables. In fact, this finding

may be further evidence that IPTS constructs are mutable, dynamic, responsive to the intervention of psychiatric hospitalization, and that subsequent decreases in PB and TB are matched by decreases in SA risk. This aligns with a number of recent studies indicating STBs are best predicted by temporally proximal measurements of predictors (Kleiman et al., 2017; Kyron et al., 2018; Ribeiro et al., 2019; Rogers and Joiner, 2019). Lastly, we find no evidence that IPTS constructs measured at admission predict rehospitalization in this population. This finding does not invalidate the IPTS, as the IPTS does not make claims about acute service utilization. However, as around 93% of patients were admitted for risk of self-harm on their index admission, this finding does rule out a predictor of a possible distal clinical outcome in this population.

Notably, in the SI and SA model series, controlling for depression symptoms always provided a better model fit. Thus, even with IPTS variables included, depression severity continues to account for relevant variance in both the presence and frequency of STB in a clinical adolescent population. IPTS constructs also account for unique variance in STB in cross-sectional models that include depression. These results suggest that depression cannot fully account for the association between IPTS constructs and STB, while the reverse is also true. We find that there may be utility assessing for both IPTS constructs and depression, as each provide unique information about the risk of STB. However, Rogers and colleagues (2018) note that controlling for depression may covary out important components of suicidal ideation (Rogers et al., 2018). Consequently, theoretical interpretation of IPTS constructs may lack coherence in our models with depression.

There were several strengths of this study. This study improves upon prior research by prospectively testing IPTS constructs in a clinically relevant population of adolescents with a validated instrument to measure TB and PB. Furthermore, the cross-sectional component of this study is highly powered and implements a more optimal modelling method than other studies with similarly distributed dependent variables. Using this improved methodology, the current study makes important contributions to our clinical understanding of how IPTS constructs operate in an adolescent clinical population.

4.1. Limitations

Although the current study featured significant methodological improvements over prior work, it still has limitations that should be addressed in future work. First, although this study used a validated instrument to measure TB and PB, it used NSSI as a proxy measure of AC. Although this AC proxy has been used in prior studies, it is only one of many pathways to the development of AC and may be an inferior measure of AC compared to instruments like the ACSS (Ribeiro et al., 2014). If so, this could account for the unexpected nature of the interaction between AC, PB and TB. Second, although this study prospectively tracked outcomes after hospitalization, it did not track the IPTS constructs prospectively. As our results indicate that IPTS constructs are associated with temporally proximal outcomes, tracking IPTS constructs and all STBs prospectively could help to determine their mutability and concurrent association after discharge. Third, 50% of patients enrolled in the prospective component of this study were lost to follow up. Although patients lost to follow up did not greatly differ from others, we cannot rule out systematic response bias. Additionally, as follow up data were obtained from parents who may have been unaware of all SAs, it is possible that post-discharge SA was underreported. This study also did not take measures to ensure patients had a reading level sufficient to complete self-report instruments. If patients were unable to comprehend these surveys, it may have undermined the validity of our measures. Lastly, although this study provides a needed contribution to the literature by investigating an adolescent clinical population at a single psychiatric inpatient unit, it is not clear whether our findings are generalizable to other populations.

5. Conclusions

This study makes methodological improvements over prior work and finds that perceived burdensomeness, thwarted belongingness and NSSI (as a proxy for AC) are associated with STBs measured on admission to pediatric psychiatric hospitalization. Specifically, perceived burdensomeness and thwarted belongingness interact to predict SI. Perceived burdensomeness, thwarted belongingness and acquired capability interact to associate with prior month SA on admission, but not as the IPTS predict. We find no evidence that IPTS constructs predict SA or rehospitalization after discharge. This study suggests that IPTS constructs have utility in this population, however, they may not relate to STBs as the IPTS predicts. Future studies should seek to replicate and extend these findings and address current limitations.

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Declaration of Competing Interest

The authors declare no competing interests.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.psychres.2019.112590](https://doi.org/10.1016/j.psychres.2019.112590).

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