



## Assessing the Impact of Telepsychiatry Implementation on Polypharmacy Reduction Among Youth Detainees

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### Abstract

The purpose of our study is to evaluate the impact of telepsychiatry services for the delinquent youth from residential placements on the total psychotropic polypharmacy. Prescription data from electronic health records for the youth patients between 2013 to 2019 was used. The total number of medications was computed for each patient per encounter, compared between the first and last telehealth encounters. Data also included information on gender, race, and date of telehealth visits. Our findings showed that youth patients with two or more medications and three or more medications are more likely to have reductions in total polypharmacy compared to that of patients with one or zero medication (41% vs. 4.41%,  $p$ -value<0.00, and 50% vs. 4.41%,  $p$ -value<0.00, respectively). Moreover, the rates of antipsychotics usage dropped by 10.1% from the first encounter to the last. Hence, our study shows evidence of polypharmacy reduction among delinquent youth.

**Keywords:** juvenile justice, mental health, polypharmacy, telepsychiatry, child and adolescent psychiatry, prescription monitoring, telemedicine

### Introduction

With the increasing prevalence of psychotropic prescribing for adolescents with mental health needs(Cooper et al., 2006; Medhekar et al., 2019; Olfson et al., 2002; Pringsheim et al., 2011; J. M. Zito et al., 2003), the use of multiple psychotropic medications is becoming increasingly common for treatment practice across US(Chen et al., 2011; Comer et al., 2010; Günther et al., 2019; McLaren et al., 2018). The overall prevalence of polypharmacy varies from 12% to 73% among the adolescent population based on different study designs(Chen et al., 2011; Comer et al., 2010; Duffy et al., 2005; Medhekar et al., 2019; Olfson et al., 2002; Wu et al., 2018). Although limited evidence exists on the safety and efficacy of treating children and adolescents with two or more psychotropic agents(Comer et al., 2010; Medhekar et al., 2019), such concomitant drug usages are associated with increased vulnerability to adverse drug interactions, risk of excessive dosing, risk of having pre-metabolic syndrome, and early death(Ito et al., 2005; Misawa et al., 2011; Shrivastava et al., 2013).

Youth involved in Juvenile Justice (JJ) and Child Welfare Services (CWS) have high rates of use of two or more psychotropic medications(Dosreis et al., 2005; Moses, 2008; Raghavan et al., 2005; J. M. Zito et al., 2003). These delinquent youth are at least two to three times more likely to meet diagnostic criteria for one or multiple psychiatric disorders than that of the youth from the general population from a similar socio-economic background(Moses, 2008; Teplin et al., 2002, 2013). Evidence from some empirical studies(Breland-Noble et al., 2004; McMillen et al., 2004; J. Zito et al., n.d.) and the raising concerns by the American Academy of Child and Adolescent Psychiatry (AACAP's 63<sup>rd</sup> Annual Meeting, 2016(Bellonci & Carlson, 2016; Lee, 2016)) about the excessive and inappropriate use of psychotropic medication to treat the youth in JJ/CWS elicits the importance of medicine prescription monitoring in this population.

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However, the juvenile facilities often have inadequate treatment facilities to provide mental health services to its youth population (Hockenberry et al., 2014; Rogers et al., 2001; Shelton, 2005; Teplin et al., 2013). This can result in inefficient treatment regimens with limited positive outcomes in alleviating symptoms and promoting a greater sense of well-being among JJ/CWS youth.

Telemedicine in residential placements can help overcome the burden of the psychiatric-service crisis in the JJ/CWS facilities (Munz, 2017; Norman, 2006; Rockhill et al., 2016). Though the adaptation of “telepsychiatry” in the JJ facilities can face barriers from psychological resistance to fear of technology, this technological advancement can increase the accessibility of psychiatric services by the board-certified child and adolescent psychiatrists (CAP) to the incarcerated youth (Leonard, 2004). However, whether the implementation of telepsychiatry can have an impact in maintaining appropriate usage of psychotropic medication and overcoming over-prescription hazards has not been studied before. Few studies have shown treatment provided to youth placed in residential treatment centers reduced the concomitant use of more than two psychotropic drugs (van Watum et al., 2013). Psychotropic medication reduction has also been shown to correlate with diminishing psychopathology scores in children (Connor & McLaughlin, 2005), positive treatment outcomes (Handwerk et al., 2008), and significant cost-savings (van Watum et al., 2013).

In this study, we assess the impact of telepsychiatry implementation in Missouri Division of Youth Services (DYS) residential placements in reducing “polypharmacy” incidences among its youth population. According to the National Association of State Mental Health Program (NASMHP) (*National Association of State Mental Health Program Directors (NASMHPD) Technical Report on Psychiatric Polypharmacy*, 2001), “polypharmacy” is defined as the concomitant use of two or more psychotropic agents in the same patient. While “same-class polypharmacy” is termed to refer to the use of more than one medication from the same class, “multi-class polypharmacy” is used to refer to the use of more than one medication from different classes for the same symptom cluster. Moreover, the total drug load or “total polypharmacy” is the total count of medications used in a patient without considering the clinical pertinence of the use of these medications. The primary purpose of our study is to explore and evaluate whether the course of treatment for the delinquent youth placed in DYS placements through telepsychiatry impacted the total psychotropic polypharmacy.

## Methods

### Data Source

The analysis of this study was done using prescription data on the youth from age 11 to 17 years from the residential placements across Missouri serving under the Department of Youth Services (DYS). The youth detainees in the Missouri DYS facilities received psychiatric care by the board-certified child and adolescent psychiatrists through a telehealth network established with the University of Missouri Department of Psychiatry (MUPC). The institutional review board (IRB) at the University of Missouri (MU) approved this research (IRB#1213074 HS). De-identified patient data on pharmacy orders from the telehealth visits were obtained from the MU Healthcare Electronic Health Record (EHR) through the i2b2 research data warehouse (Mosa et al., n.d.) within period 2013 to 2019. The dataset consists of unique patient identifiers, unique i2b2 encounter identifiers for each patient, start date of the prescription, medication names. The dataset also consists of information on demographics such as race and gender for all the patients.

### Data Transformation and Selection Criteria

For each unique patient identifier, a list of prescribed medications is extracted per unique i2b2 encounter identifier. The medication names are mapped with their hierarchical classes using i2b2 medication ontology. The medication names indicated the use of psychotherapeutic (PSYC) agents, central nervous system (CNS) agents, cardiovascular agents, respiratory agents, gastrointestinal agents for treating the youth patients. Since our main concern is polypharmacy in psychiatric drugs, medications only related to the treatment of psychiatric conditions (PSYC and CNS agents) are retained for further analysis. PSYC agents included antipsychotics and antidepressants, and CNS agents included stimulants, anxiolytics, anticonvulsants, etc.

The main component of this study is to glean evidence on psychotropic polypharmacy reduction prescribed from the telepsychiatry visit. For this purpose, the total polypharmacy (TP) is computed as a sum of the number of medications for each patient per encounter. However, to measure the change in the polypharmacy level across the telehealth visits, one way is to compare the total number of medications of the last encounter to that of the first encounter.

For this purpose, only patients with more than one visit are selected, and the prescribed medications for the first and last telehealth encounters for each patient are extracted. We believe that the change in total medication, if observed is an outcome of the psychiatric care provided to the youth patients.

### Outcomes Measurement

We developed two approaches for identifying the pattern of changes in total medications. First, the difference in total medication is computed by determining whether the total number of medications has increased, decreased, or remained the same (no change).

This will compare the number of patients for each category (increase, decrease, and no change). Comparing the proportion of patients with respect to gender and race can identify any significant differences in the above categories for males and females and black and white patients. Moreover, considering the total pharmacy, we also compared the proportion of patients in these categories with respect to “No medication,” “Exactly one medication,” “Two or more medications,” and “Three or more medications.” Also, the class proportions were compared for specific drug classes like antipsychotics and antidepressants. However, the overall counts of increase or decrease will not provide a clear picture as it will consider a drop from total medication number of 8 to 4 and 2 to 1 as same and label it as a decrease.

Second, the change in pattern is identified by classifying the total number of medications into identified states and then determining the changes in states for all patients from first to last. For this purpose, we have classified the total number of medications into “Low” and “High,” and termed this as “Level of Polypharmacy (LOP),” using a threshold of zero to two as “Low” and three and above as “High.” The rationale behind this classification is that a combination of three and above psychotropic medicines can have more significant health hazards than anything less or equal to 2. The change in states from High at the first visit to Low at the last visit will reveal how many patients starting at the high level of polypharmacy have transitioned to the low level of polypharmacy by the last telehealth encounter. This leads to four possible state transitions among all patients, “Low to Low,” “Low to High,” “High to High,” and “High to Low.” Here, “Low to High” indicates the state “Low” at the first visit and the state “High” at the last visit. A status change from “High to Low” will indicate how many patients (who obtained treatment through telehealth) could reduce polypharmacy, and a status change from “Low to Low” will show for how many patients, medication number has remained steady and well below risk of over-prescribing. However, “Low to High” will reveal the number of patients who moved to a higher risk group from a low-risk level of polypharmacy. Our expected outcome would be a high proportion of patients in the “Low to Low” and “High to Low” transition states as compared to the “Low to High” transition state.

Moreover, combining both the status transitions and the change in total medication (increase, decrease, or no change) can reveal specifically how many patients had an increase or a decrease in total medication number but remained in the same state in the first and last visits. To observe a clear picture, we have also introduced another layer in the comparison. We have identified the exact transition in the total number of medications from the first to the last encounter for each transition state. This will reveal the distribution of specific transitions in each broader class of transition state. Since the time difference between the first and last encounters is not equal for all the patients, we have also calculated the time difference in weeks (“week difference”) to understand if big jumps in medication numbers have any dependency over the time differences. Moreover, we have also included layers of comparison using variables like gender and race with state transitions and the change in total medication (increase, decrease, or no change) to identify any variation in proportion due to changes in gender or race.

R version 3.4.4 (R Foundation for Statistical Computing, Vienna, Austria) (R Core Team, 2018) were used for the data analysis. Computations were performed on a Mac Book Pro running macOS Catalina version 10.15.2 with 16GB of RAM.

### Statistical Methods

Descriptive statistics were calculated to examine demographics (race and gender), medication evaluation at first and last encounters, and the time difference between the two visits in weeks. Z-test for proportions were used to assess changes in medication prescribed from first to last encounters. T-tests were used to compare the Total Pharmacy across gender, race categories for first and the last encounters, and mean week differences. Statistical significance was set at a p-value less than 0.05. All tests were two-tailed.

## Multinomial Logistic Regression (MLR)

The four state transitions (“Low to Low,” “Low to High,” “High to High,” and “High to Low”) for each patient are a nominal outcome variable. We are interested to know whether the “odds” of patients in state transition “High to Low” is higher or lower as compared to that of the “Low to High” category.

Here, “odds” is annotated positively with a perception that high “odds” of “High to Low” over “Low to High” implicates a strong influence of the psychiatric care provided through the telehealth network in reducing polypharmacy. To determine these “odds ratios,” we have applied multinomial logistic regression models considering state transitions as an outcome variable.

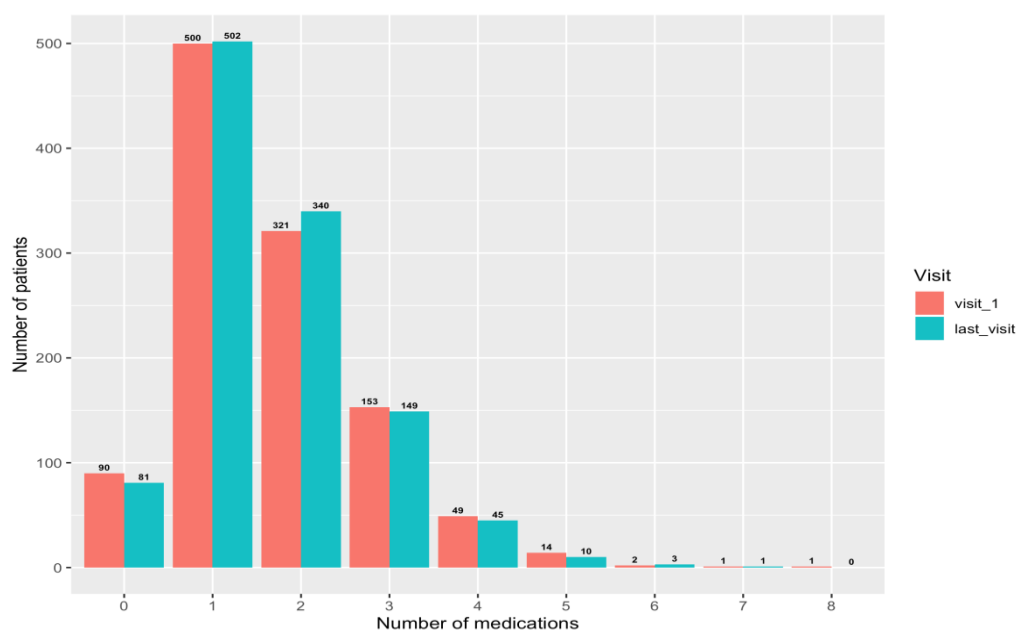
Multinomial Logistic Regression is an extension of binomial logistic regression used to model nominal outcome variables with more than two categories (Agresti, 2018). In MLR, the log of odds of the outcomes is modeled as a linear combination of the predictor variables. Exponentiation of the estimates from MLR models can provide the odds ratio, i.e., the ratio of the probability of choosing one outcome category over the probability of choosing the reference category. We have used R package “nnet” (Ripley et al., 2016) for executing MLR in our dataset and have run two separate models, (1) “Status ~1”, which reveals the “odds ratios” for the individual categories over the reference category “Low to High,” and (2) “Status ~ Gender + Race + WeekDifference,” includes the effect of these predictors in the odds ratios. The p-values are also computed to infer whether the odds ratios obtained are statistically significant (p-value < 0.05).

**Table 1.** Comparing Mean of Total Polypharmacy between Males vs. Females, Black vs. White, and First and Last Encounter.

Encounter	Male	Female	t-test (p-value)	White	Black	t-test (p-value)
First Visit	1.61	2.07	<0.0005*	1.74	1.60	0.0434*
Last Visit	1.63	1.86	0.0121*	1.75	1.56	0.0025*
t-test(p-value)	0.71	0.0453*		0.6191	0.2922	

## Results

The dataset contains 1269 unidentified unique patient identifiers (ID) with 6926 telehealth encounters. There are 100 unique medications, including psychotherapeutic (PSYC) agents, central nervous system (CNS) agents, cardiovascular agents, respiratory agents, gastrointestinal agents, etc. Since we consider only the PSYC and CNS agents for the data analysis, 58 (29 of each category) are retained in the dataset. After excluding the patient IDs with less than 2 telehealth encounters, the final sample size consists of 1131 patients. There are 168 females and 963 males in the youth population receiving treatment via telehealth encounters through the MUPC telehealth service. As the primary focus of our study is to compare polypharmacy levels from the first to the last telehealth encounters, for each patient, prescription data of the first and the last telehealth encounters were used.



### Measuring Change in Total Polypharmacy

The total polypharmacy (TP) for the first and last visits are shown in **Error! Reference source not found.** The values of TP lie within 0 to 8 for the first visit (visit\_1) and 0 to 7 for the last visit. **Error! Reference source not found.** indicates that there are slight differences in the TP distribution for the two encounters.

**Table 1** compares the mean TP for males vs. females, black vs. white races, and first and last encounters. Mean TP was significantly more for females than males for both first and last encounters (2.07 vs. 1.61 with  $p$ -value<0.0005, and 1.86 vs. 1.63 with  $p$ -value=0.0121, respectively). Females had a significant decrease in mean TP from first to last encounter (2.07 vs. 1.86,  $p$ -value=0.0453). Also, TP was significantly more for white patients than black patients for both first and last encounters (1.74 vs. 1.60 with  $p$ -value=0.0434 and 1.75 vs. 1.56 with  $p$ -value=0.0025).

**Table 2** shows the change in total polypharmacy with categories “increase,” “decrease,” or “no change” with respect to specific medication counts and medication classes. Among the patients who started with two or more medications in the first visit, significantly had more decrease than an increase in TP (41% vs. 11.1%  $p$ -value<0.05). Also, among the patients who started with three or more medications, 50% had a decrease, and only 10% had an increase ( $p$ -value<0.05).

**Table 2.** Comparison of Change in Total Polypharmacy Between the First and Last Encounters with Respect to Medication Usage Count and Types of Medications. \*P-Values that are Statistically Significant.

			Change in Total PharmacyfromFirstVisit to LastVisit			
MedicationUsageCount	FirstVisit (%)	LastVisit (%)	Decrease	Increase	No Change	Z- test for Proportions Increase vs. Decrease (p-value)
No medication	90 (7.96)	81(7.16)	0	46	44	59.1(<0.0000) *
Exactlyonemedication	500(44.2)	502(44.4)	29(5.8)	144(28.8)	327	90.8(<0.0000)*
twoor more medications	541(47.8)	548(48.5)	222(41.0)	62(11.5)	257	120.7(<0.0000)*
Threeor more medications	220(19.5)	208(18.4)	110(50)	22(10)	88	81.9(<0.0000)*
Type of Medications						
Antidepressants	624(55.2)	657(58.1)	134(21.5)	183(29.3)	814	9.74(0.0018) *
Antipsychotics	402(35.5)	361(31.9)	140(34.8)	86(21.9)	905	15.9(<0.0000) *

However, TP for patients who started with zero and exactly one medication increased significantly ( $p$ -value<0.05). About 29.3% of patients who started with antidepressants ( $n$ =624) had an increase in TP, whereas significantly fewer patients had a decrease (21.5%). Patients who started with antipsychotics ( $n$ =402) had significantly more cases with a decrease in TP than an increase (34.8% vs. 21.9%  $p$ -value<0.05). **Table 3** compares the three status categories with demographics (race and gender) and week difference. Significantly more females had a decrease in TP compared to that of males ( $p$ -value<0.05). Whereas, among the males, females, black and white patients, there is no significant difference in the number of increase and decrease. Also, there is no difference in mean week difference across all categories.

**Table 3.** Comparison of Change in Total Polypharmacy Between the First and Last Encounters with Respect to Demographics and Week Difference. \* P-Values That Are Statistically Significant.

Characteristics	Decrease (n=251)	Increase (n=252)	No change (n=628)	Z- test/t-test Increase vs. Decrease(p- value)
<b>Gender</b>				
Male (n=963)	203 (21.1%)	220 (22.8%)	540 (56.1%)	3.42(0.0646)
Female (n=168)	48 (28.6%)	32 (19.0%)	88 (52.4%)	3.42 (0.0646)
Z- test (p-value) - Male vs. Female	4.23(0.0398) *	0.98(0.3217 )	0.65(0.4209)	
<b>Race</b>				
White (n=600)	130(21.7%)	140(23.3%)	330(55.0%)	0.57 (0.4492)
Black (n=441)	106(24.0%)	98(22.2%)	237(53.7%)	0.45 (0.5013)
Z- test (p-value) - White vs. Black	0.68(0.4080)	0.12(0.7285 )	0.12(0.7339)	
<b>Mean Week Difference</b>	44.09	42.4	-	0.555
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### Identifying Transitions in Level of Polypharmacy

After classifying the TP into categories of low and high levels of polypharmacy, the frequency distribution between the categories for each visit is shown in **Table 4**. Out of the 1131 patients, 220 started with a “High” level of polypharmacy, while 911 started at the “Low” level. Among the patients who started with a high level, 41.8% (n=92) patients showed a transition to the low level (High to Low). Moreover, among the 911 patients in the low level, 91.2% (n=831) remained in the low level of polypharmacy (Low to Low), while 8.8% (n=80) transitioned to high level from low.

**Table 4.** Frequency Distribution of the States of Level of Polypharmacy for the First and Last Telehealth encounters

First Telehealth Encounter	Last Telehealth Encounter		Z- test for proportion (p-value)
	High (n=208)	Low (n=923)	
<b>High (n=220)</b>	128 (58.2%)	92 (41.8%)	284.85 (<0.0000) *
<b>Low (n=911)</b>	80 (8.8%)	831 (91.2%)	96.35 (<0.0000) *

**Figure 1** shows each of the transition states (High to High, High to Low, Low to High, and Low to Low) and the distribution of each change in medication number observed. Among the patients with transition state High to High, 52.34% started with 3 medications and ended with 3 by the end of the last visit; one patient TP was lowered from 8 to 4.

Patients showed a decrease in TP from 4 to 3, 5 to 3, 5 to 4, 6 to 3, and 8 to 4 (10, 2, 4, 1, 1, respectively, a total of 14.1%) among the patients who started with high level and ended with being still in the high level.

For the high to high transition state, very few patients showed an increase in TP, 14 patients showed an increase from 3 to 4, 3 patients showed an increase from 3 to 5, 3 patients showed an increase from 4 to 5, 2 patients jumping from 5 to 6. For the High to Low transition state, all patients showed a decrease in TP, 2 patients jumped down from 3 to 0, 44 patients had a decrease of TP from 3 to 2, with 10 patients lowering down from 4 to 1, 9 from 4 to 2 and 4 from 5 to 1. Among the patients who started at Low and transitioned to High, 43.75% (n=35) had an increase from 2 to 3, and 37.5% (n=30) had an increase from 1 to 3 medications, whereas big jumps like 0 to 5, 1 to 4 and 1 to 5 are observed in 1, 4, and 1 patient, respectively. For the patients who started at Low and ended with Low (n=911), increase in TP was observed from 0 to 1 (n=32 patients), 0 to 2 (n=9 patients), and 1 to 2 (n=109 patients). Moreover, a decrease in TP was also observed from 1 to 0 (n= 29 patients), 2 to 0 (n=6 patients), 2 to 1 (n=106 patients), with 327 patients starting with 1 and remaining with 1 TP, 169 patients starting with 2 and still remaining with 2 by the last encounter.

### Comparing LOP Transitions with Demographics and Week Difference

**Table 5** compares the difference in TP among the different state transitions between different gender and race classes. Among the patients who had transitioned from “High to High,” a significantly higher proportion of females had an increase in TP (4.2% vs. 1.6% with p-value=0.0238). Among the patients in the “High to Low” states transition, a significantly higher proportion of females had a decrease in TP (14.3% vs. 7.1% with p-value=0.0026). In the “High to High” group, significantly more black patients had a decrease in TP as compared to that of white patients (2.5% vs. 0.8% with p-value=0.0313). Also, in the “Low to Low” group, 15% of black patients were observed to have a decrease in TP, with 0% white in the same category. However, a higher proportion of white patients was observed to have an increase and no change in TP as compared to black patients (2.8% vs. 0.9%, p-value=0.0289 and 9% vs. 5.4%, p-value=0.0318, respectively). However, week difference was not significantly different across any groups for gender and race.



**Figure 1.** Comparing States Transitions with Specific Medication Changes and TP changes

**Multinomial Logistic Regression (MLR) on LOP Status**

**Table 6.** The odds ratios (OR) from model (1) shows the risk of “High to Low” is higher ( $RR > 1$ ) compared to that of the reference category, “Low to High”, though the effect is not significant at 5% level of significance ( $p\text{-value} > 0.05$ ). Also, OR ( $p\text{-value} < 0.05$ ) of “Low to Low” is very high comparatively to “Low to High”, which shows that the probability that a patient will transition from Low to Low LOP status is higher for those patients who will transition from Low to High. The odds ratios from model (2) are provided for three different predictors in Table 2. All the ORs are less than one for Gender with reference category female.  $OR = 0.32$  ( $p\text{-value} < 0.05$ ) means the probability for males to transition from high to low compared to that of low to high is less compared to that of the females. For variable Race, all the ORs are not statistically significant, the less than one values indicate black youths having less chances of transitioning from high to low compared to that of low to high, as compared to the white youths. The “WeekDifference” is a numerical variable, so the OR is interpreted as increase in risk with one unit increase in week difference. The “WeekDifference”, though not significant, have similar chances of having the two transitions (High to Low vs. Low to High) as shown by OR of 1.

**Table 5.** Comparing Transitions in LOP with Difference in Total Polypharmacy Across Gender and Race

States Transition	Difference in Total Polypharmacy between first and last encounter	Gender			Race		
		Male (n=963) (%)	Female (n=168) (%)	Z- test/t- test (p-value)	White (n=600) (%)	Black (n=441) (%)	Z- test/t- test (p-value)
<b>High to High (n=128)</b>	Decrease	14(1.5%)	4(2.4%)	0.30 (0.5809)	5(0.8%)	11(2.5%)	4.63(0.0313) *
	Increase	15(1.6%)	7(4.2%)	5.11(0.0238) *	17(2.8%)	4(0.9%)	4.77(0.0289) *
	No change	69(7.2%)	19(11.3%)	2.87(0.0902)	54(9.0%)	24(5.4%)	4.64(0.0312) *
	Week Difference	35.9	30.4	0.2704	36.2	34.7	0.7985
<b>High to Low (n=92)</b>	Decrease	68(7.1%)	24(14.3%)	9.05(0.0026) *	57(9.5%)	29(6.6%)	2.87(0.0904)
	Increase	0	0	--	0	0	--
	No change	0	0	--	0	0	--
	Week Difference	43.1	50.6	0.3846	47.5	43.2	0.5370
<b>Low to High (n=80)</b>	Decrease	0	0	--	0	0	--
	Increase	72(7.5%)	8(4.8%)	1.22(0.2699)	47(7.8%)	28(6.3%)	0.84(0.3601)
	No change	0	0	--	0	0	--
	Week Difference	45.6	42.6	0.7423	40.7	47.3	0.2701
<b>Low to Low (n=831)</b>	Decrease	121(12.6%)	20(11.9%)	0.01(0.9105)	0	66(15%)	95.87(<0.000) *
	Increase	133(13.8%)	17(10.1%)	1.39(0.2385)	76(12.7%)	66(15%)	1.14(0.2855)
	No change	471(48.9%)	69(41.1%)	3.22(0.0730)	276(46%)	213(48.3%)	0.54(0.4626)
	Week Difference	36.4	32.9	0.2008	35.0	38.2	0.1490

**Table 6.** Results from Multinomial Logistic Regression

		Multinomial Logistic Regression (MLR) Model (2): Status ~ Gender + Race + WeekDifference		
	MLR Model (1): Status ~1 Odds Ratios (p-value)	OR for Gender (Reference: Female)	OR for Race- Black (Reference: White)	OR for WeekDifference (Time difference between first and last telehealth encounter)
Reference Group: Low to High	-	-	-	-
High to Low	1.15 (0.36059)	0.32 (0.00902) *	0.87 (0.66555)	1.00 (0.94100)
High to High	1.60 (0.00097) *	0.37 (0.02048) *	0.89 (0.70843)	0.99 (0.02723) *
Low to Low	10.39 (0.0000) *	0.78 (0.51162)	1.42 (0.16345)	0.99 (0.00658) *

## Discussion

The main aim of the present study was to assess whether, for juvenile youth patients at residential placements, polypharmacy reductions can be achieved as a treatment outcome of telepsychiatry. The results showed that youth patients starting with two or more medications and patients starting with three or more medications are more likely to have reductions in total polypharmacy as compared to that of patients starting with one or zero medication (41% vs. 4.41%, p-value <0.0000 and 50% vs. 4.41%, p-value <0.0000, respectively). These findings are consistent with earlier reports on polypharmacy reduction in youth from residential treatment settings (Connor & McLaughlin, 2005; Handwerk et al., 2008; van Watum et al., 2013). The use of antipsychotics is increasingly prescribed for psychotropic treatments with a continuum increase observed in recent years (Rubin et al., n.d.). Interestingly, from our findings, the rates of usage of antipsychotics dropped by 10.1% from the first encounter to that of the last. Among the patients who had a decrease in TP, 193 had reduction by 1 medicine, 40 had reduction by 2 medicines, 13 had reduction by 3, and 5 had by 4 medicines. Out of youth patients having no change in medicines (n=628), 327 remained at 1 medicine, 169 remained at 2, 67 remained at 3, 14 remained at 4, 2 remained at 5, with extremes to 6 to 6 and 7 to 7 having each one patient only. These results indicate that the telepsychiatry services provided at the DYS placements can monitor irrational polypharmacy and prevent overprescribing, even though the study was not primarily set up with an intent to reduce polypharmacy. Most of the studies in the literature assessed the importance of telepsychiatry in increasing accessibility, the feasibility of the model, adherence to treatment, providers' and patients' satisfaction in general, with very limited literature focusing on its adaptation in the juvenile settings (Antonacci et al., 2008; Becevic et al., 2016; Fox & Whitt, 2008; Myers et al., 2006; Wang & Alexander, 2014). This study establishes the scope of telepsychiatry in curtailing polypharmacy and accentuates the importance of designing rational and evidence-based use of pharmacotherapy delivered through telepsychiatric services to the delinquent youth.

The transitions among the levels of polypharmacy give a more precise depiction of how polypharmacy is changing over the two visit comparisons. Comparing the transition states proportions, many patients moved from a high level of polypharmacy to a low level (41.8%), and many of them retained a low level of polypharmacy (91.2%). However, some patients moved from low to high (8.8%), where we observed high spikes in TP, like 0 to 3, 0 to 5, 1 to 4, or 1 to 5 medicines, which indicates the presence of highly disturbed patients among the delinquent youth with complicated psychotherapeutic treatment regimens. These results show evidence of the benefits of adherence to treatment as provided through telepsychiatry to the delinquent youth, who otherwise may remain untreated. From our findings, females are observed to have a significant reduction in the TP as compared to men. Moreover, females have higher odds to transition from high to low vs. transitioning from low to high compared to males. These results emphasize the findings that adolescent girls respond to treatment better than boys of the same age in residential settings, though they are diagnosed with higher rates of psychiatric conditions (Handwerk et al., 2006). While white patients have been found to have higher TP as compared to black patients, polypharmacy reduction was found to be unassociated with race, as seen in other studies (van Watum et al., 2013).

The study has several limitations. The difference in time between the first and last encounters is not the same for all patients as the treatment is an ongoing regimen, providing care unless the youth patients are moved elsewhere. For this, we included the week difference variable in our study, which came to be unassociated with the polypharmacy reduction in every scenario.

We also observed for some patients, TP increased, even with a difference of over one year between the two visits considered for this comparison study. Hence, we can claim there is no alteration in polypharmacy reduction with an increase or decrease the in week-difference.

Moreover, there was no control group in this study. The juvenile youth who received psychiatric care using telemedicine would not have received any other form of treatment during their stay. However, randomization among treatment and control groups for psychotropic drugs is not ethically justifiable (van Wattum et al., 2013). All the indications of polypharmacy reduction from this study can be assumed to be in effect due to the telepsychiatry intervention. For future studies, other variables like dosage reduction and comorbidity reduction from EHR platforms can assess the treatment benefits and efficacy for the delinquent youth through this intervention.

## Conclusion

In conclusion, this prospective study explored whether psychotropic medication regimens could be reduced over the telepsychiatry visits for delinquent youth serving in residential placements. The overall positive indications show evidence of potential benefits of a telehealth network reaching delinquent youth and providing care using the best available evidence-based treatments.

## Authors' Contribution:

HI contributed to literature review, data pre-processing, data analysis, evaluation of results, and manuscript writing. ASMM (primary supervisor) and LYW (project PI) contributed to project design, manuscript editing, and reviewing.

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