Title: Payer Readiness for Technology Implementation (P-RTI) Tool Application and Assessment

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Structured Abstract

Purpose: To understand technology adoption behaviors in the substance use disorders (SUDs) field.

Scope: Eight states, with 344 providers participating in the Interest and Use of Technologies Survey and 144 providers participating in the Multilevel Technology Adoption Analysis.

Methods: Two data analysis were conducted. The first was the cross-sectional analysis of telemedicine technology interest, use, and barriers in SUD organizations in the United States for 11 patient-centered technologies. The second was a multilevel structural equation model of the technology adoption process of how payer and provider variables affected the use of two targeted technologies: telephonic and video-based SUD therapy.

Results: Among the 11 technologies assessed, the average percentage of organizations that had high or very high interest in the different technologies ranged from 35.54% for virtual worlds to 69.97% for computerized screening/assessments. The overall average interest in all the technologies assessed was 37.1%.

The multilevel structured equation model analysis discovered that a path exists from provider implementation readiness (as assessed by providers), to provider readiness for implementation, to behavioral intent to implement the technology. For video-based therapy, the path extended to use of the technology.

Key words: Telemedicine, technology adoption, substance use disorders

Purpose

The conducted research consisted of two analyses: a) the assessment of interest and use for 11 patient-centered technologies in the substance use disorders (SUDS) treatment field and b) a Multilevel Technology Adoption Analysis of how payer and provider variables affected the use of two targeted technologies: telephonic and video-based SUD therapy. The original purpose of the study was to test an instrument called the Payer Readiness for Technology Implementation (PRT-I) on use of two of the patient-centered technologies: telephonic and video-based therapy. This instrument, as well as the payer and provider-level moderating factors we included in the study proposal, are part of the Multilevel Technology Adoption Analysis reported in this study.

The patient-centered technology and use assessment evaluated the following 11 technologies: a) computerized screening and assessment tools, b) texting appointment reminders, c) texting motivational messages, d) organizational web portal for patients to use, e) video-based therapy, f) mobile apps for use during treatment, g) mobile apps for post-treatment recovery, h) secure recovery support chats, I) telephone-based therapy, j) telephone-based post-treatment recovery supports, and k) virtual worlds for treatment.

The Multilevel Technology Adoption Analysis assessed the payer level by a) the Payer Readiness for Technology Implementation (P-RTI), as a progressive assessment by payers, and b) payer processes of influence. The dimensions in both assessments were payer-initiated training sessions, committees to support implementation, public relations activities, resource provisions, reimbursement, or contractual incentives.

The provider level was assessed by a 21-question survey of SUD provider's readiness for technology adoption. Areas assessed were organizational environment, organizational motivation, technology usefulness, technology promotion, and the technology implementation process.

Scope

Background
Technology and Substance Use Disorders (SUD)

Telemedicine patient-centered health IT applications improve health,[1-5] provide access to hard-to-reach populations,[6,7] and extend a clinician's ability to monitor and influence patient behavior beyond the exam room.[8,9] Despite the great promise of telemedicine, its potential benefits have not been fully achieved.[10-12] Uptake has been slow[13] and is disproportionly lower for underserved populations.[14] This slow uptake provides an opportunity to improve healthcare by reducing the gap between suggested evidenced-based health IT use and actual practice.

The uptake of health IT has been the slowest in the SUD field, when compared to all the health disciplines.[15] Twenty-four million Americans suffer from an SUD, more than the number of people diagnosed with diabetes.[16] Yet only 4 million received SUD treatment.[16] Those who suffer from an untreated SUD die on average 22.5 years earlier that those without such a diagnosis,[17] and their total costs to society, including productivity and health- and crime-related costs, exceed $600 billion annually.[18] For opioid use disorders alone, 143 people die per day due to overdoses in the United States. In addition, many injuries and diseases (e.g., cancer, diabetes, cardiovascular problems, cirrhosis, and HIV/AIDS) are caused or exacerbated by alcohol or illicit drug abuse.[19]

A disturbing chasm between those who need addiction treatment and those who receive it has persisted for the past decade.[16] Evidence-based telemedicine offers opportunities to increase access to addiction treatment services and improve addiction care. This study will primarily focus on two specific examples of telemedicine technology: a) *telephone (or telephonic)-based therapy,* which can result in greater substance use abstinence than in-person therapy,[20] and b) *video-to-video therapy,* which increases access to SUD services[21]; performs as well as face-to-face visits[22]; and is preferred by patients due to convenience and confidentiality. The use of these technologies in addiction treatment in 2011 was less than 1%[23]; and a significant increase in their use and impact is possible.

Study Summary: The conducted research consisted of two analyses: a) the assessment of interest and use for 11 patient-centered technologies in the substance use disorders (SUDS) treatment field and b) a Multilevel Technology Adoption Analysis of how payer and provider variables affected the use of two targeted technologies: telephonic and video-based SUD therapy. The original purpose of the study was to test an instrument called the Payer Readiness for Technology Implementation (PRT-I) on use of two of the patient-centered technologies: telephonic and video-based therapy. This instrument, as well as the payer and provider-level moderating factors we included in the study proposal, are part of the Multilevel Technology Adoption Analysis reported in this study.

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Context: A Multilevel Systems Issue

Payment policy can be a key factor in provider behavior. A payer's approval of and willingness to pay for a procedure has considerable influence on provider practice. Payer policies have played an instrumental role in the broad adoption of health practices such as use of beta blockers with stroke patients,[24] antidepressant medications for mental health patients,[25,26] and technology, such as Electronic Health Records (EHR).[27,28] Payer strategies promote new practice adoption through financial incentives such as direct pay,[29] increasing case rates,[30,31] or including a clause in provider contracts specifying what practices should be used.[32] Other strategies payers have applied to promote new practices include providing education on the new practice[33] and engaging in inter-governmental relations to find new payment sources or remove regulatory barriers.[34]

Organizational context is also a factor in technology adoption. A rich research history exists of individual adoption models that explain what makes individuals want to abandon traditional practices in favor of new technologies.[35,36] Some of these models have expanded to explain how the organizational context influences individual adoption decisions.[37,38] Paradoxically, research on the patient factors related to health IT adoption often ignores the key role of payer and organizational policy. Health IT adoption research lacks models that define the factors influencing payer and organizational behavior with the same clarity as models explaining the factors that influence individual health IT adoption behaviors.

Hence, an aim of this study was to understand how the interplay between payer and organizational factors affects SUD organizations' use of patient-centered technologies.

Settings

Eight states, including Illinois, Iowa, Kentucky, Massachusetts, Ohio, Oklahoma, Oregon, and South Carolina participated in the study. Organizations eligible for the survey were providers in those states that received grant funds from the Substance Abuse Prevention and Treatment Block Grant (SABG) and had greater than 100 admissions per annum. The SABG block grant is a federally-funded block grant that is intended to support substance abuse prevention and treatment for the underserved in the United States.[39]

Participants

Within the 8 states, the state addiction department participants completed the P-RTI survey. The breakdown of the job titles of individuals who competed the survey (n=2 per state) were: state addictions bureau chief (n=5), clinical director (n=4), director of planning & development (n=4), IT director (n=1), and special projects director (n=1).

For the providers surveys: The Interest and Use of Technologies survey was completed by 344 SUD providers offering inpatient, detoxification, and outpatient levels of care. The Multilevel (or multivariate) Technology Adoption Analysis of technology adoption was conducted by 144 providers offering outpatient treatment only.

Incidence

Does not apply to this study.

Prevalence

Does not apply to this study.

Methods

The described study was approved by the University of Wisconsin's Health Sciences Institutional Review Board.

Study Design

The study had two sets of analyses. The first was a cross-sectional survey of telemedicine technology interest, use, and adoption concerns in SUD organizations in eight states.

The second was a multilevel (or multivariate) structural equation model of the technology adoption process. The logic flow (Illustration 1) for this analysis included a) payer implementation readiness (via the P-RTI) through the eight SUD state payer perspectives at M0 (baseline), b) payer Implementation behaviors through the provider perspectives at M12, c) provider readiness for technology adoption (RIS) at M0, d) provider implementation behavioral intent at M0, and e) real time technology use rates at Ms1-12.

Figure 1: Technology Adoption Logic Model and Chronology of Data Collection
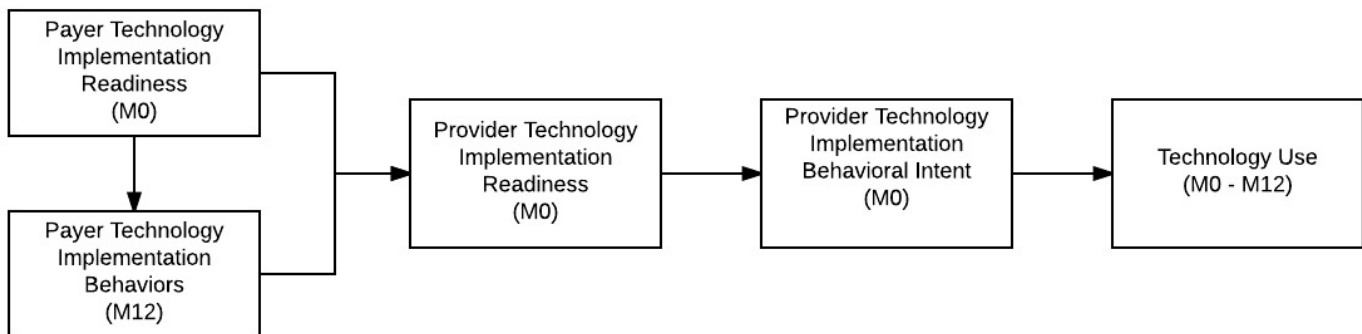
Data Sources/Collection

For the cross-sectional interest and use survey, between 10/1/15 and 1/30/16, the eight states' addiction treatment authorities e-mailed the on-line survey link to the Executive Directors of 551 eligible SUD treatment organizations (publicly-supported organizations with 100+ SUD admissions). The telemedicine technology interest, use, and adoption concerns in SUD organizations in the 8 states were collected as part of the baseline data collection. Survey results were tabulated by the University of Wisconsin–Madison, and respondents were informed that all results would be kept confidential, with the states only receiving aggregate data feedback.

For the multilevel structural equation model of the technology adoption process, the P-RTI survey data was collected from the state payers (n=8) at M0 (baseline). For the providers, the portion of the sample of organizations that provided outpatient services was n=144. These organizations provided the monthly telephone and video use data and completed the payer implementation behaviors report as part of providing their use data during M12. A research assistant cross-validated the use data by calling each of the n=144 organizations to inquire about the availability of telephonic or video counseling. When a disparity occurred, we checked with the organization's clinical director to clarify data accuracy.

For the qualitative analysis, all interviews were audio recorded and transcribed verbatim. The breakdown of the job titles of the individuals who competed the survey (n=2 per state) were: state addictions bureau chief (n=5), clinical director (n=4), director of planning & development (n=4), IT director (n=1), and special projects director (n=1). Qualitative data was managed using ATLAS.ti software.

Interventions: Did not apply to this observational study.

Measures

For the cross-sectional SUD Interest and Use of Technologies Survey, the technologies assessed were based on technologies investigated by Molfenter et al.[40] in a 2013/2014 five-state SUD technology implementation project, along with technologies that state participants requested. The technologies assessed in all eight states included a) computerized screening and assessment tools, b) texting appointment reminders, c) texting motivational messages, d) organizational web portal for patients to use, e) video-based therapy, f) mobile apps for use during treatment, g) mobile apps for post-treatment recovery, h) secure recovery support chats, I) telephone-based therapy, j) telephone-based post-treatment recovery supports, and k) virtual worlds for treatment.

The measure of interest consisted of five items with Likert response categories that ranged from 1= very low to 5=very high. The measure of use was measured using a dichotomous response format (1=yes, 0=no). The measure of implementation concerns consisted of five items with Likert response categories that ranged from 1= low to 5=critical. The surveys were sent to the SUD organizations' Executive Director.

The two targeted technologies used in the Multilevel Structural Equation Model modeling were telephone and video-based therapies. These two technologies were chosen because two technologies had to be selected to reduce respondent burden. These two technologies were projected to be the two most widely used. The measures used for this model were:

- Payer implementation behaviors, based on provider perspectives via the P-RTI. At baseline, the state addiction department participants completed the P-RTI survey. Two surveys were completed per state and the two survey scores were averaged for the analysis.
- Payer implementation behaviors, based on the provider perspectives. At month 12, the SUD treatment sites were asked to assess the payer processes of influence. We selected payer processes of influence based on our observations in more than 30 previous multi-state projects addressing new practice implementation and adoption. The limited evidence, beyond case examples, supporting the payer processes of influence for practices for health IT implementation underscores the need for metrics to quantify and study the impact of payer actions on provider health IT adoption behavior. Since validated measures for these factors are lacking for health IT adoption, this study adapted similar measures taken from evidence-based practice implementation research (see supporting references in Table 1) to create the five-point Likert measures for each of the payer processes of influence developed for this research.

Table 1: Payer Process of Influence Moderating Measures

Measures	Rationale	Supporting References
Training Sessions	*Build operational awareness; provide observability of ability to use; present case for benefits over costs; and promote self-efficacy*	*Rieckman et al., 2007[41]*
Public Relations Activities	*Build recognition awareness and provide visible example(s) of payer interest*	*Finnerty et al., 2009[42]*
Develop committee(s) to support implementation	*Build cross-department support with the state and buy-in by organizational users*	*Magnabosco, 2006[33]*

Table 1 (Cont.)

Measures	Rationale	Supporting References
Resource provisions	Provide funds to pay for implementation (typically one-time) and a source of funds for ongoing support of adoption (typically via reimbursement)	*Rieckmann et al., 2009*[29]
Reimbursement practices	Lack of reimbursement gives providers a financial reason for not using the health IT	Heinrich & Hill, 2008[43]
Contract incentives	Incentives can result in positive reinforcement for health IT use and penalties for not using a health IT can become a disincentive for use.	Finnerty et al., 2009[42]

- Provider implementation readiness: A leader from each organization completed the Readiness for Implementation Model (RIS) at baseline. The RIS tool was developed by Gustafson et.al.[44] The RIS elements selected addressed organizational variables found to align with creating an organizational environment receptive to technology implementation. These variables include leadership style, staff cohesion, inter-department cooperation, organizational history of innovation, and level of internal turbulence.[44]

- Provider implementation behavioral intent: A leader from each organization stated their interest in implementing telephonic and video counseling in their organization at baseline on a 5-point scale, with 1=Strongly Disagree and 5=Strongly Agree.

- Technology use data: Each treatment organization provided the primary data (# of new patients receiving telephone therapy, and # of new patients receiving video e-therapy) monthly for 12 months (Ms1-12). Each treatment agency received an online link to a standardized technology use survey as advised by University of Wisconsin–Madison's Institutional Review Board (IRB). The data was aggregated to calculate the number of telephonic or video therapies provided by month.

For the qualitative analysis, as part of the payer technology implementation readiness (via the P-RTI) assessment, the state addiction department participants completed a qualitative assessment during the P-RTI survey conducted in M0. The questions asked were related to a) strengths and weaknesses they perceived regarding all of the 11 technologies assessed, and b) barriers and facilitators to adopting telephonic and video-based counseling.

Data Analyses

Two data analysis were conducted. The first was the cross-sectional analysis of telemedicine technology interest, use, and technology barriers in SUD organizations, through the Interest and Use of Technologies survey. The second was a Multilevel Technology Adoption Analysis, using a structural equation model of the technology adoption process that integrated provider and payer data.

For the Cross-Sectional Interest and Use analysis: frequency counts, means, and percentages were used to report technology interest, use, organizational readiness characteristics, and technology implementation concerns. A Latent Class Analysis (LCA) was conducted to profile groupings of SUD treatment organizations based on organizations' use of the selected technologies (listed in Table 2). LCA is widely used to detect homogeneity in a potentially heterogeneous group through evaluating and then minimizing associations among responses across a set of ordered categorical indicators. This determines if organizational groupings of technology use exist based on their self-reported use patterns. We used Mplus version 7.11[45] to conduct the LCA, to identify different homogeneous subgroups of respondents who were identified based on their response to a set of items. LCA yields a probabilistic approach: each organization is assumed to belong to one class.

The basic LC cluster model has the form of

$$f(\mathbf{y}_i|\theta) = \sum_{k=1}^{K} \pi_k \prod_{j=1}^{J} f_k(y_{ij}|\theta_{jk}),$$

Here, y_i denotes an object's scores on a set of observed variables, K is the number of classes, and π_k denotes the prior probability of belonging to latent class K or, equivalently, the size of class K, where J denotes the total number of indicators and j a particular indicator. To determine the number of classes, we used various information criteria, such as Akaike Information Criteria (AIC), sample size adjusted AIC, Bayesian Information Criteria (BIC), and Consistent AIC (CAIC) (see Rissanen[46]; Sclove[47]; Fraley and Raftery[48]). The smaller the BIC, AIC, adjusted AIC, and CAIC, the better the model fit.

The number of classes were chosen based on the following selection criteria: (1) interpretability; (2) parsimony; (3) lowest Information Criteria scores (AIC, adjusted AIC, BIC, and CAIC); (4) entropy>0.7; (5) average posterior probability in each class >0.75 and no more than 10% overlap/cross-membership between non-contiguous classes; and (6) at least 2.5% of the total sample size in each class.

After identifying latent class groupings, we were interested in using the latent class variables for further analysis, and to explore the possible differences between the identified class variables and the observed auxiliary measures assessing organizational readiness and technology implementation concerns. For this auxiliary analysis, we used the Bolck, Croon, and Hagenaars (BCH) method[49,50] to explore differences between selected auxiliary variables of interest and each of the individual classes.

*For the Multilevel Technology Adoption Analysis, we constructed t*wo models, one for video use, the other for phone use. Technology use was based on a latent class from a growth mixture model of use items for both phone and video. Two structural Probit growth mixture models were estimated using Bayesian estimation with non-informative priors. Models were constructed using Mplus Version 8 software.

For the qualitative analysis, we used a directed content analysis[51] of the qualitative data to develop a deeper understanding of the barriers and facilitators to technology adoption. In addition, an inductive approach based on grounded theory and dimensional analysis[52-55] will be applied to identify and explore contextual and processual factors that affect payer influence.

Limitations

Self-report data. The data used in the analysis is based on self-report data. Hence, perceptions of technology use could differ from organization to organization.

Definition of the technology: Organizations could vary in their interpretations of the definitions of the different technologies. For example, a web portal for one organization could be simply a web page, while for another, it could be secure portion of a webpage that allows secure exchange of clinical information. In our study, we know that interpretations of the use telephonic counseling differed because of the varied and prolific use of this technology in society. Conversely, it was much easier for organizations to know if video counseling was being used or not due to the presence of specific equipment or software purchased to use this technology.

Response Rates: Response rates in three of the states were below 60%. This could affect the generalizability of the findings.

Generalizability: This project only surveyed publicly-funded organizations and those with more than 100 outpatient admissions. In addition, this sample only represented eight of the 50 United States.

Results

Principal Findings & Outcomes

For cross-sectional interest and use: a total of 342 public SUD treatment organizations completed the Interest and Use of Technologies Survey. The overall return rate was 65.5%, with rates of return ranging from 42.4% in Oregon to 100% in South Carolina and Iowa. The provider implementation readiness data was collected.

Among the 11 technologies assessed by the 342 organizations, the average percentage of organizations that had high or very high interest in the different technologies ranged from 35.54% for virtual worlds to 69.97% for computerized screening/assessments. The overall average interest in all the technologies listed in Table 2 was 37.1%. The percentage use of the different technologies was less than the percentage of interest in their use. Virtual worlds had a higher percentage of interest (35.54%), but a low percentage of actual use (.55%). Computerized screening assessments had a high percentage of interest (69.7%) with an actual use of 44.63%, the highest among the technologies assessed. On average, difference the between the percentage of organizations that had high interest and actual use was 37.32%, with over a third of the organizations having interest in a technology, but not using it. Texting appointment reminders had the largest gap (55.18%) between high interest and actual use, while the lowest gap between high interest and actual use was in telephone-based therapy (20.67%).

Table 2: Interest In and Use of Selected Technologies

Technology	% High Interest	Relative Rank	% Currently Using	Relative Rank	% Difference (Interest – Use)	Relative Rank
Computerized screening/assessments	69.97%	1	44.63%	1	25.34%	9
Texting appt. reminders	68.40%	2	13.22%	6	55.18%	1
Web portal for patients	58.40%	3	14.60%	5	43.80%	4
Mobile apps for post-treatment recovery	55.65%	4	9.09%	7	46.56%	2
Video-based therapy	54.82%	5	20.39%	4	34.43%	8
Telephone-based recovery support	53.99%	6	29.48%	2	24.51%	10
Recovery support chats	53.44%	7	6.89%	8	46.55%	3
Telephone-based therapy	49.04%	8	28.37%	3	20.67%	11
Texting motivational messages	45.18%	9	2.48%	10	42.70%	5
Mobile apps for treatment	40.77%	10	4.96%	9	35.81%	6
Virtual worlds	35.54%	11	0.55%	11	34.99%	7

Responses tended to be high for several of the organizational technology implementation characteristics. The following technology implementation traits ranked greater than 4 on a 5-point Likert scale, with 5 being Strongly Agree: a) Our clinicians and support staff work well together (4.23); b) Our departments work cooperatively together (4.19), c) Our leaders are innovative (4.11). The traits a) Our organization has a history of successful innovation (3.89) and b) There is a high degree of turbulence in our organization (reverse coded) (2.37) had lower scores.

The results from the technology implementation concerns assessment ranged from 2.62 to 3.90 on the five-point Likert scale, with 5 being Critical, 4 being Very High, and 3 being a High concern (Table 3). Information security was the highest concern, with a 3.9 score (representing "very high" concern), and patient attitudes toward the technology was the lowest concern, with a 2.62 score (representing a "high" concern) (Table 5). The results from the both the organizational implementation readiness and implementation concerns assessments will be compared to the LCA groupings described in the following section.

Table 3: Technology Implementation Concerns Inventory Results

Item	Average	Organizational Concern
Informational security	3.90	Very High
Reimbursement policy towards the technology	3.78	
Regulation barriers	3.53	
The technology's impact on workflow	3.25	High
Counselor attitudes toward the technology	2.71	
Patient attitudes toward the technology	2.62	

Results from the LCA indicated that the optimal fit supported a three-class structure from the organization's self-reported technology use, with lowest BIC, adjusted AIC, and CAIC. The average posterior probability for each class was > .74, with class 1 = .932, class 2 = .866, and class 3 = .948. Total percent of overlap/cross-membership was only 1.9%. (Table 4)

Table 4: Posterior Probabilities

Class	Entropy	BIC	AIC	Adj AIC	CAIC
1	-	3038.434	2995.596	3003.536	3049.434
2	0.693	2928.513	2838.942	2855.544	2951.513
3	0.811	2908.36	2772.061	2792.326	2943.366
4	0.721	2952.646	2769.61	2803.536	2999.646

Class 1 N = 27 (7.4%), Class 2 N = 101 (27.8%), Class 3 N = 235 (64.7%).

The three groupings based on the use rates of the 11 technologies were characterized as follows:

- Class 1: High overall technology use or "Innovators" (n=27: 7.4%),

- Class 2: High for traditional technologies only (e.g., phone and video) or "Technology Traditionalist" (n=101: 27.8%),
- Class 3: Low overall technology use or "Low Tech" (n=235: 64.7%) (Class 3) (Figure 1) (Figure 2).

"Innovators" (Class 1) had high interest in all technologies except for video-based therapy. Class 2 or "Technology Traditionalists" showed a preference to the more established technologies such as web portals, video-based therapy, and phone-based technologies. Class 3 or "Low Tech" was lower than Classes 1 and 2 for nearly all technologies. A comparison of the different classes and organizational traits uncovered a few associations. The "Innovators" (Class 1) differed significantly from "Low Tech" (Class 3) by the readiness trait of "Our leaders are innovative" (p=002). The "Innovators" (Class 1) also differed from the "Technology Traditionalists (Class 2) and "Low Tech (Class 3) for the readiness traits of a) "Our clinicians and staff work well together" (p=.001) and b) "Our departments work well together," with both being significantly higher in the Innovator organizations. The "Low Tech" (Class 3) differed from the "Innovators (Class 1)" and "Technology Traditionalists" (Class 2) by having significantly lower "History of Successful Innovation" (p=.000) ratings.

Figure 2: Latent Class Analysis (LCA) Estimated Probabilities
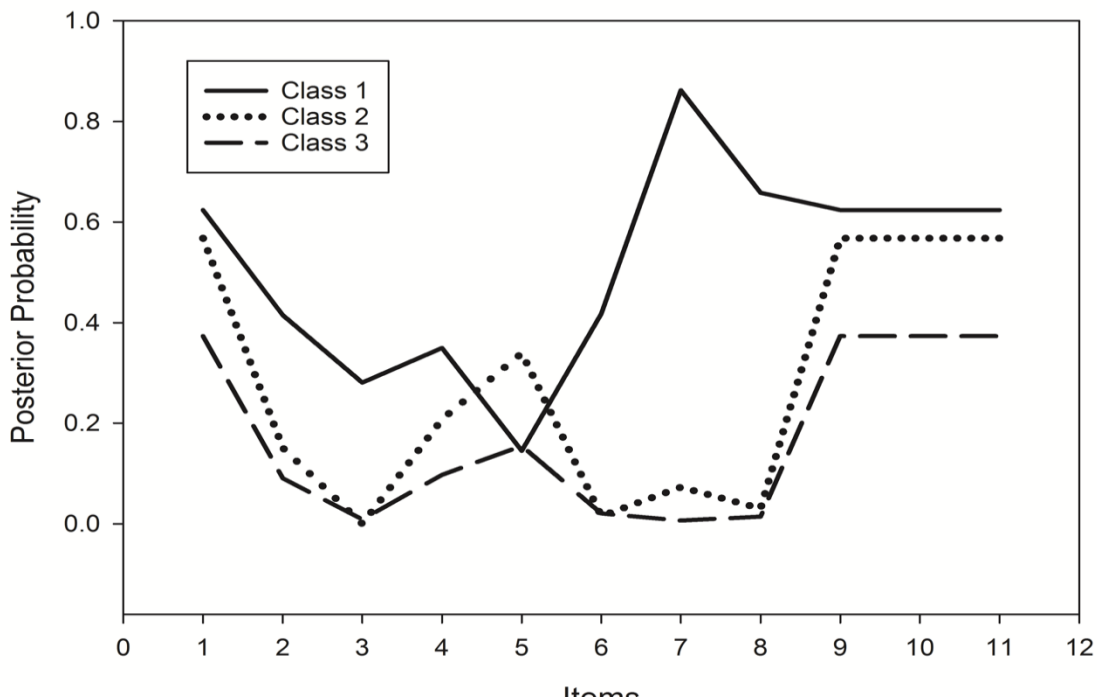
Legend	
1 = Computerized Screening/Assessments	7= Mobile Apps for Use Post-Treatment
2= Texting Appointment Reminders	8= Secure Chats for Recovery Supports
3= Texting Motivation Messages	9= Telephone-based Therapy
4= Organizational Web Portal	10= Telephone-based Post-Treatment Recovery
5= Video-Based Therapy	11= Virtual Worlds for Treatment
6= Mobile Apps for Use During Treatment	

For the Multilevel (or multivariate) Technology Adoption Analysis, the structure in Figure 3 was used to assess the multilevel relationships use of video and telephonic-based therapies. Two growth classes were identified for both video and phone, with two video use classes of 12.4% use versus 87.6% non-use, and two phone classes of 22.2% use and 77.8% non-use. The non-use class was used as reference in the models. 12.40% of the organizations used video-based therapy, with a range of 0% in Illinois and Oregon and 20% in Kentucky. 22.2% of the organizations used telephonic therapy for outpatient services, with a range of 0% in Kentucky and Oregon to 47% in Iowa.

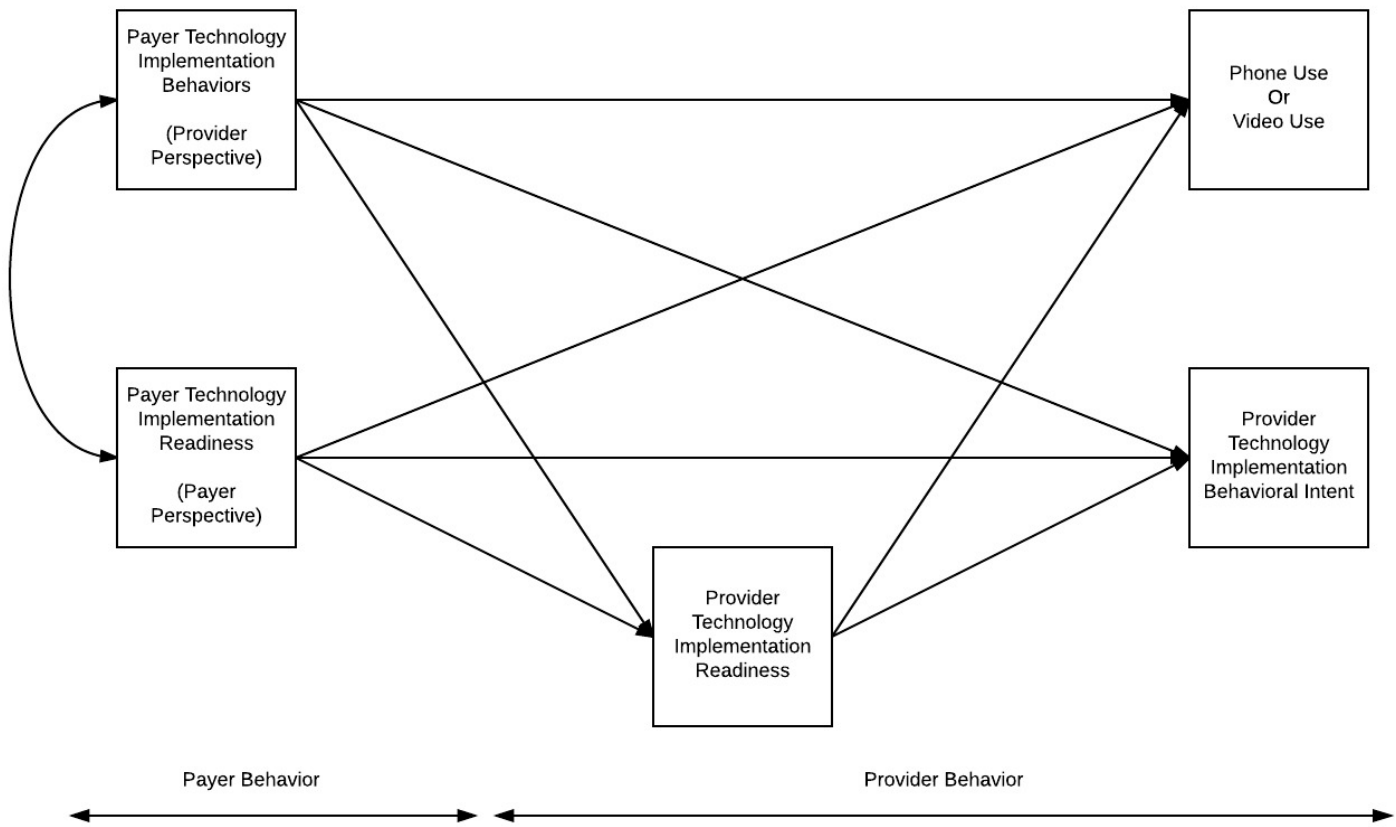**Figure 3: Multilevel Technology Adoption Analysis Format**

Figure 4 outlines the significant relationships in the use of video-based therapeutic services. For payer behaviors, there was a relationship between payer implementation readiness (based on payer perspectives) and payer implementation behaviors (based on provider perspectives). Also, the path of payer implementation behaviors, provider implementation readiness, provider implementation behavioral intent, and video use data was significant and has an r-squared value of 24.6.

For the different study aims. First, the P-RTI did have an association with payer practices. But, the P-RTI did not show a direct significant association with video use, and actually had an inverse relationship with provider readiness. Second, the payer implementation behaviors did have a relationship with provider implementation readiness, but no direct relationship with video use. Third, an analysis of the path of payer behaviors, provider readiness, provider behavioral intent, and video use demonstrates how the payer and provider activities interact to result in video use. This demonstrates a multilevel relationship where payer and provider behaviors play an important role in behavioral intent and use.

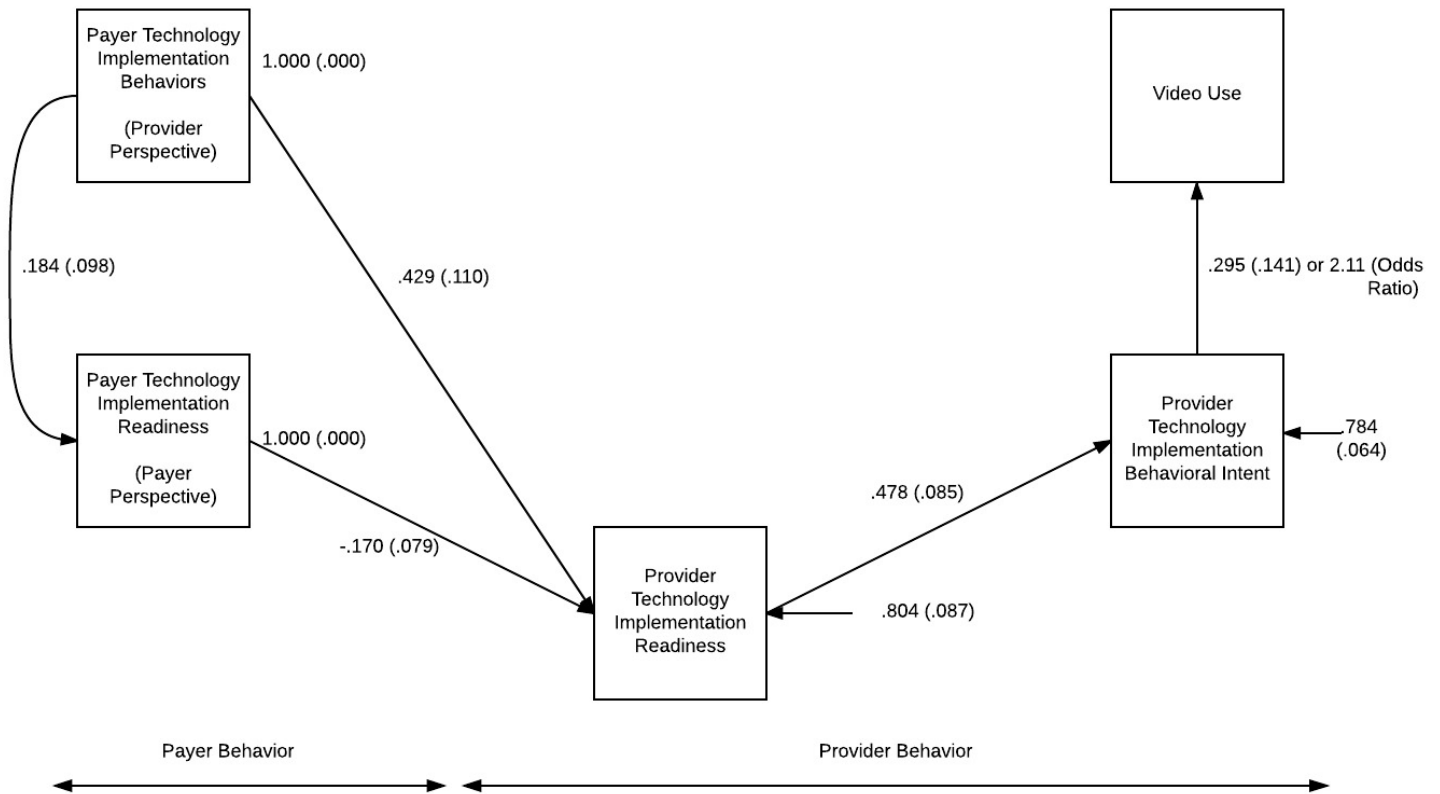**Figure 4: Multilevel Technology Adoption Relationships for Video-Based Therapy**


Figure 5 outlines the significant multilevel relationships in the use of telephone-based therapeutic services. This diagram follows many of the same paths as those for video-based services, with two notable differences. First, there is no relationship between payer implementation readiness (based on payer perspectives) and payer implementation behaviors (based on provider perspectives). Second, the path of payer technology implementation behaviors, provider technology implementation readiness, and provider technology implementation behavioral intent stops at provider technology implementation behavioral intent, with no relationship to telephonic therapy use.

For the different study aims: First, the P-RTI did not have a significant association with any other factors, calling into question its viability. Second, the payer implementation behaviors did have a relationship with provider readiness, but no direct relationship with use of telephonic therapy. Third, the path analysis demonstrates a multilevel relationship where payer and provider behaviors play an important role in behavioral intent, but not use.

Figure 5: Multilevel Technology Adoption Relationships for Phone-based Therapy
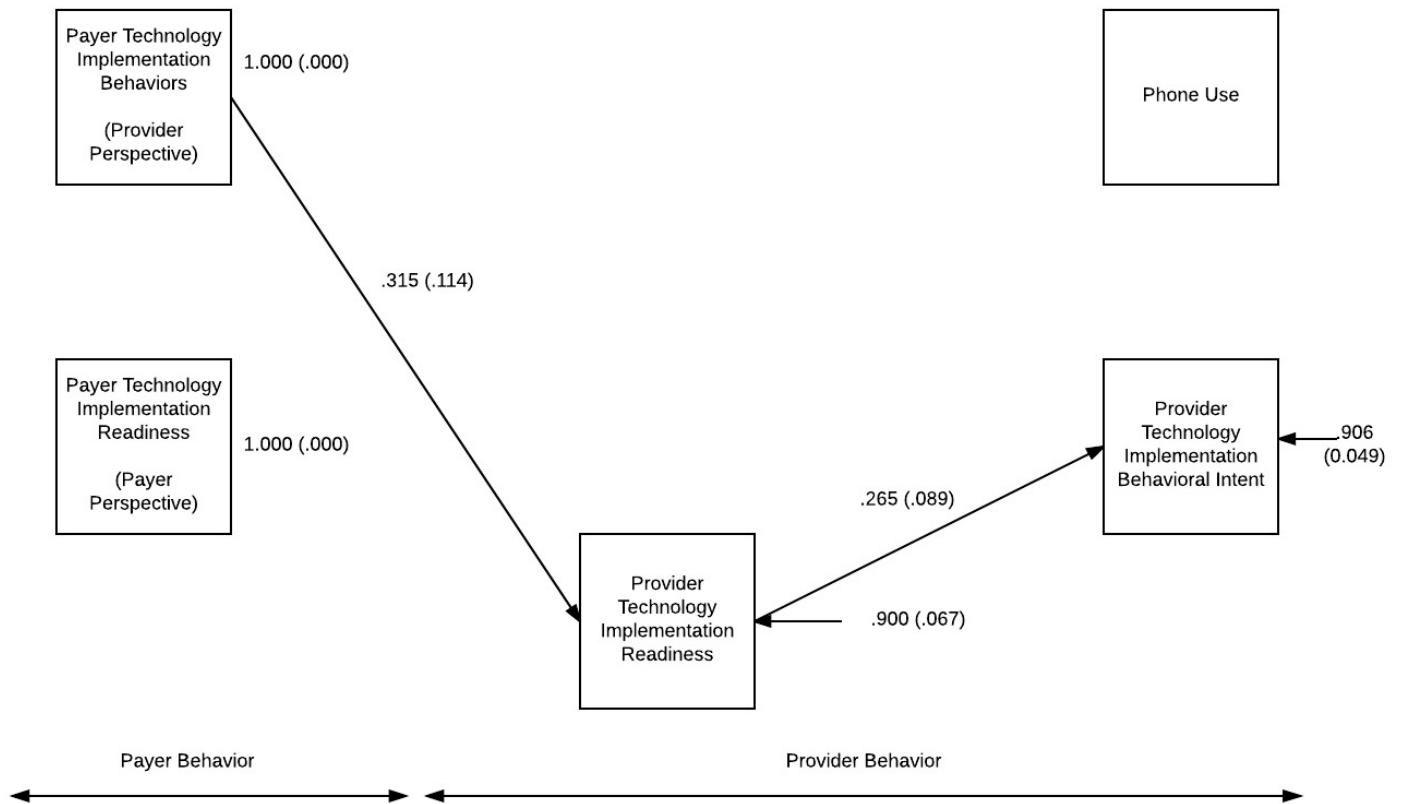
The summary of this analysis is that the path of payer behaviors, provider readiness, provider behavioral intent, and video use demonstrates how the payer and provider activities interact to result in targeted technology behavioral intent to implement and use. The evidence would be more complete if the path between telephonic behavioral intent and use was significant. Varying interpretations of telephonic counseling, by the different people who completed the behavioral intent and technology use surveys, could have caused this discrepancy.

For qualitative analysis, an analysis of the barriers and facilitators from the state payer perspective adds clarity to their perceived payer processes of influence, based on the themes that arose and the frequency count of items discussed (Tables 5 & 6). Overall, the biggest barriers facing providers and organizations are financial, with technology implementation and organizational change issues following close behind. Organizations have tight budgets and must redesign many of their current processes, such as billing and reimbursement, while ensuring no regulations are violated. Employees and providers must then be trained on how these new processes will fit into the organization. Lastly, security and patient confidentiality are a big undertaking, due to the fact that the new technologies are virtual and not face-to-face. There is a belief that these technologies will provide long-term benefits and ensure patients stay in treatment. Although the new technologies can be costly and hard to implement, organizations have been finding financial sources, such as grants, and some champions are continuously driving the technologies. For payers, willingness to implement is a significant facilitator. The P-RTI was not able to adequately assess payers' willingness or ability to support adoption of targeted technology financially.

Tables 5 & 6: Barriers and Facilitators to Technology Adoption (Payer Perspectives)
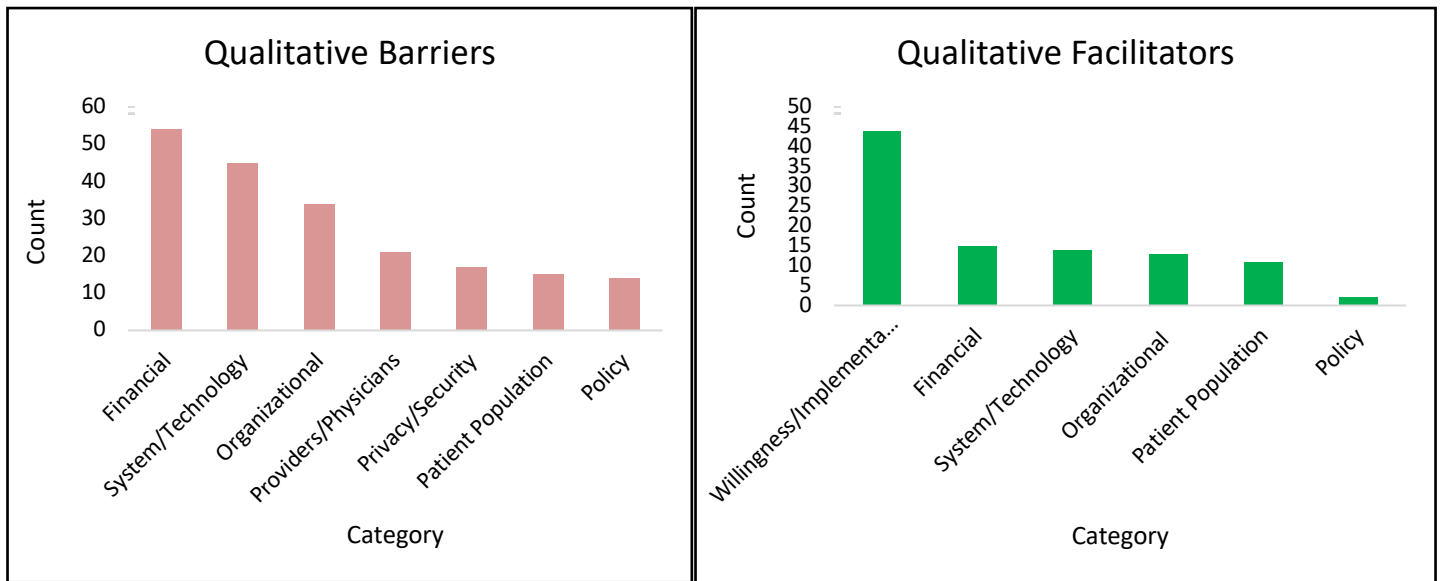
Discussion

Public Health: Internationally, alcohol results in 3.3 million deaths each year.[56] Opioid overdoses have become the leading cause of accidental death in the United States.[57] Internationally, the prevailing paradigm of SUD treatment is through face-to-face therapy sessions that are sometimes provided in combination with SUD treatment pharmacotherapies. Telemedicine applications can potentially broaden access to SUD information, services, and support. Several telemedicine technologies have emerged to augment traditional treatment approaches, with many supported by research evidence.[58-60] Counselors understand and appreciate the need to connect with patients between appointments.[61] Similarly, patients want the safety net of support and community that digital technologies can provide.

SUD Technology Use: the pending demand for use of technology in SUD services: The Interest and Use Survey analysis on average indicated a 37% difference between interest and use of the 11 technologies assessed. This suggests that there will be a "pull" for new technologies in this field. Yet, the two technologies we assessed, telephone and video-based therapy, are arguably among the two most assessable technologies, but their use rates were below 50%.

Technology Adoption Modeling: Technology adoption models must be multileveled. This research suggests that payers and providers play a key role in technology adoption. This expands on previous research that describes the role patients play in technology adoption.

This research confirms the role of payers in SUD treatment technology adoption. It also demonstrated that provider perception of payer behaviors is an influential factor in payer adoption modeling.

In developing a multilevel model (from Figures 4 & 5), this research produced and tested two scales that can contribute to the technology adoption field: Payer Technology Implementation Behaviors (based on the provider perspectives) and the Provider Technology Implementation Readiness scales.

Significance

This study suggests that SUD treatment organizations in the United States are interest in greater use of telemedicine technology. Use of telemedicine in SUD treatment settings will probably begin with computerized assessments and texting appointment reminders, followed by the use of telephone, video, and mobile health applications. Organizations pursuing these goals will have demonstrated innovative tendencies in other organizational practices and have top leadership supporting use of telemedicine.

The Multilevel Technology Adoption Analysis found that the P-RTI could not prospectively determine payer behaviors in supporting technology. But, providers' assessments of payer support of telephonic and video-based technologies were associated with provider readiness to adopt a targeted technology. The Multilevel Technology Adoption Analysis also discovered that a path exists from provider implementation readiness (as assessed by providers), to provider readiness for implementation, to behavioral intent to implement the technology. For video-based therapy, the path extended to use of the technology.

Implications

For technology use in SUD Services: In our study interest in and use of technology in 344 SUD organizations, the two telemedicine technologies that generated the most interest were computerized screenings/assessments and texting appointment reminders. Interestingly, both technologies represent opportunities to increase face-to-face clinical time with the patient. Computerized assessments reduce time needed to collect demographics and other background information, allowing counselors more time to discuss clinical issues. Texting appointment reminders has been found to reduce appointment no-shows[62]; higher show rates result in more clinical time with patients.

> Implication #1: The initial patient centered addiction treatment technologies to be adopted in the SUD field are those that enhance clinician face-to-face time.

Organizations and their clinicians are also interested in increasing the clinical and social supports available to patients outside the face-to-face clinical encounters, as evidenced by the fact that two of the three largest gaps between interest in technology and reported use in the study were a) mobile apps for post-treatment recovery at 46.56%, and b) recovery support on-line chats at 45.55%. These two specific gaps, as well as the overall gap between interest in and use of the 11 technologies we assessed, represent potential areas of telemedicine growth in SUD treatment settings. Yet, currently, the two technologies we assessed, telephone and video therapy, arguably among the two most assessable technologies, have limited rates of use.

> Implication #2: The gap between interest in and use of technologies suggest a continued need for models to facilitate technology adoption in the SUD field.

According to the LCA analysis, those in the "Innovator" organizations, were more likely to use texting and mobile app technologies than those in the "Technology Traditionalist" and "Low Tech" organizations. This difference may be based on Innovators having the greater staff and departmental cooperation needed to implement these technologies. This could be because a staff person other than the clinician often sends the text or engages in the mobile app activities. Also, to gain access to the information generated from the mobile apps, clinicians typically need other staff to secure information from the mobile app server. In some cases, the electronic health record needs to be redesigned to integrate patient information from the mobile app into the traditional clinician workflows. Another observation was that "Low Tech" organizations were less likely than "Technology Traditionalists" and "Innovators" to use telephone-based recovery and therapy services. Of the technologies assessed, telephone services were the lowest tech services. Hence, Low Tech organizations lack a history of technology adoption that promotes embracing the more advanced technologies. In the LCA analysis, study participants' concerns with information security, regulation, and reimbursement did not create differences between the LCA use classes. Organizational history, leadership, and inter-department as well as interpersonal cooperation created the differences in use between classes.

> Implication #3: There appears to be a diffusion curve for SUD firms classified as "Innovators" and "Technology Traditionalists" that are the early adoptions.

For technology adoption modeling: A multilevel model was needed to provide insights into technology adoption behavior.

For payer perspectives: The ability to use prospective payer preferences to explain future technology behavior was disproven in this analysis, with the P-RTI showing no associations with payer behavior. Based on the qualitative analysis, lessons that emerged as to why this was not the case were: a) the rapidly changing health care environment could have changed payer preferences over time, b) some payers' enthusiasm for all technologies may not take into account the willingness to implement or pay for these technologies, c) assuring that those directly involved in making the decisions for technology adoption within the payer organization are assessed, and d) all significant payers in the market must be assessed, not just one or two primary payers.

> Implication #4: Different models are needed to prospectively predict payer behavior.

This analysis demonstrated providers' ability to assess payer behaviors in real time and to associate that with their readiness to implement a targeted technology and behavioral intent to use that technology. This confirms the key roles payers play and that providers' perceptions of those behaviors has an association with their implementation readiness.

> Implication #5: Providers' perceptions of payers' support for a targeted technology is associated with provider readiness and behavioral intent to adopt the targeted technology.

However, developing a model to prospectively project payer behavior should be continued to be pursued because of the payers' important role in the technology adoption process. Several next steps that could contribute to this modeling are: a) use social network analysis theory to determine who should be assessed (or interviewed) within the payer agency, other payer agencies, and community stakeholders; b) instead of just focusing on action steps, such as support for reimbursement and reduction of regulatory burden, also focus on the implementation steps needed to affect these action steps; and c) provide a clear definition of the targeted technology and how it will be used. In our analysis, we were concerned that multiple interpretations of the use of telephone-based therapy might have hindered generating the same results that were achieved with the video-based therapy.

> Implication #6: New prospective predictive models that can predict payer behaviors to support technology adoption are needed and a broader and more detailed assessment than what the P-RTI provided are suggested.

This research provides initial results of a multilevel model of technology adoption. The model needs further validation to determine if it can consistently predict use of a targeted technology. Settings attempting to rapidly adopt a targeted technology across a population of providers would be opportune settings for testing this model.

> Implication #7: Further testing of the predictive validity of the developed multilevel technology adoption model in needed.

The model could also be used to assist with a) making decisions on whether or not to implement a technology in an environment, or b) developing interventions to address implementation weaknesses identified by the model.

> Implication #8: The developed multilevel adoption model could be used a) as an aid to determine whether or not to implement a technology and b) to identify which implementation weaknesses to address to increase likelihood of successful technology implementation.

Conclusions

Overall, improving SUD treatment outcomes and decreasing overdose deaths has become a top priority in public health. Telemedicine could be a mode to achieved these goals or, at the least, provide new methods for delivering addiction treatment and recovery supports. Telemedicine technologies' ability to have an impact on SUD accessibility and outcomes will depend on treatment providers' ability to implement them into practice. Currently, however, there continues to be a significant gap between research findings and application.

List of Publications and Products:

For this R21 study, the following manuscripts have been submitted or are under various stages of development.

- The paper titled "Use of Telemedicine in Addiction Treatment: Current Practices and Organizational Implementation Characteristics," by Molfenter TD, Brown R, O'Neill A, Kopetsky E, and Toy A. is under review by the *International Journal of Telemedicine and Applications*.

- An article addressing the multilevel technology adoption model based on the path of Payer Technology Implementation Behaviors, Provider Technology Implementation Readiness, Provider Technology Implementation Behavioral Intent, and Technology Behavioral Use is being prepared for submission. The target journal for publication is the *Journal of Telemedicine and Telecare*.

- An additional assessment of the accessibility of remote therapy was conducted via phone calls to 144 agencies. The caller asked if the agency provided telephone or video-based therapy services, as opposed to typical in-person services. The resulting data provided insights into staff reactions to this request—a request that is likely to become more commonplace. The sum results of these phone calls and the reactions of the staff receiving these calls are being prepared for publication.

- A paper will be prepared reporting on the psychometric properties and predictive validity of the Payer Technology Implementation Behaviors and Provider Technology Implementation Readiness scales.

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