Telebehavioral Health Resource Allocation: A System Modeling Approach

Rural areas are challenged with mental health provider shortages and it is often infeasible for these underserved clients to travel to see a service provider in a nearby city. Enabling access to care through technology in rural community centers has proven successful for low-income residents of the Greater Brazos Valley in East-Central Texas. The model for care requires a partnership between academics and community leaders which supports training of psychology doctoral students at no cost to the underserved, rural clients. Providing this service requires funding from the university and community partners, so we perform a system analysis using the Systems Engineering Initiative for Patient Safety Model along with a System Dynamics Causal Loop Model to demonstrate the impact of offering this service and evaluate prospective policy changes. Using System Dynamics modeling, we demonstrate the potential impact of a telebehavioral health system on resource utilization and access to care in the healthcare continuum. The model shows the change in burden on existing resources when the flow of patients through the mental health care system changes.

INTRODUCTION

The Telehealth Counseling Clinic (TCC) at Texas A&M University offers free counseling services to residents of the Greater Brazos Valley in Central Texas. The TCC operates in a hub-and-spoke model in seven of the eight Greater Brazos Valley counties. The demographics of the service counties have a wide range; populations between 13,000 and 220,000 (Census, 2018), poverty between 13% and 24%, and Medicare enrollment between 10% and 30% (CMS, 2018). Clients are most often seen individually or as a couple, however, there have been several evidence-based psychotherapy and skills groups offered through TCC including smoking cessation, grief, and mindfulness. The TCC counselors serve clients from a variety of backgrounds, however, over half of TCC clients do not possess insurance and most fall below 100% of the federal poverty level guidelines for 2017.

All of the counties in the region are designated as mental health professional shortage areas. Compared to the best performing counties in the country that have provider to population ratio of 1 to 200, the region as a whole has a ratio of 1 to 8,000 and the lowest performing county in the region has a ratio of almost 1 to 17,000. Even in the most urban county, it will usually take months for a client to get in with a mental health provider. Additionally, most of these providers are "cash only" and charge rates TCC clients cannot afford.

In most cases at the TCC, telehealth services are delivered through synchronous, face-to-face video conferencing where therapists are centrally located at the University and clients are seen at satellite community centers or primary care settings nearer to their residences. In some cases, audio only telephone services to the client's home or mobile phone are conducted to overcome barriers that prevent them from being able to be seen at a satellite location (e.g. transportation barriers, poor physical health, lack of childcare). The community centers and primary care facilities are centrally located within the county or in the most populous city (Sanchez Gonzalez et al., 2019). Since opening in 2009, TCC has served over 1,000 clients, provided over 10,000 hours of counseling, valuing over 1.2 million dollars in services.

The TCC team is comprised of psychology doctoral students, clinical supervisors, research advisors, and student workers. Clients can receive up to 20 sessions barring an excess of missed appointments. The sessions are held by doctoral student practicum counselors offering them the opportunity to learn the nuances of providing care at a distance (McCord, Saenz, Armstrong, & Elliott, 2015). These students will provide the next leap forward for telebehavioral health by filling the gap of clinicians who understand and will use telehealth services in their practices. Some of the differences in mental health care provided in-person versus using technology include the need to protect data transmission, being prepared to handle psychological emergencies from a distance, and having a plan for disruption in connectivity.

CASE STUDY

Combining telehealth technology with mental health care may have new challenges to overcome. We use the TCC as a case study to understand the challenges of this system integration through systems modeling approaches. This study aims to determine which telebehavioral health system components are important to study. Using this information, we aim to understand what policy decisions can be implemented to facilitate sustainability and scalability of the system.

MODELING APPROACH

Systems Engineering Initiative for Patient Safety Model

The Systems Engineering Initiative for Patient Safety (SEIPS) modeling approach was developed to better understand the health system components most at risk for causing errors that lead to reduced patient safety (Carayon et al., 2006). To use this model, first the work system elements are defined using five categories: technology and tools, organization, tasks, environment, and person. Then the processes core to the systems function are defined along with other related processes. Finally, outcomes are assessed from two perspectives, the patient-specific outcomes and organization-level outcomes. This progression from work system to process to outcomes is observed in a linear cause-and-effect relationship; feedback to the work system on processes and outcomes enable additional model capabilities. SEIPS models are most often used either to

proactively design a system that reduces failure points or to reactively evaluate system failures (Holden et al., 2013). In this study, we use a SEIPS model to define, understand, and evaluate variables to measure for a study.

We used a three-step process to develop a SEIPS model of the TCC. First, we observed the work system of the central hub and discussed the system components with the clinic staff. We also visited the satellite sites to observe the client-facing side of TCC service delivery. Second, a base model was developed and iterated through the observation phases. Finally, the model was shared with the key TCC stakeholder group; a clinical supervisor and post-doctoral researcher, and the clinic director. Using their input, the model was further refined to its current state.

Causal Loop Model

Using the results obtained from the SEIPS model, we are able to inform the variable selection for a systems dynamics (SD) causal loop model (CLM). A CLM describes causal relationships using diagrams and can be analyzed with differential equations. Variables of interest are represented with nodes and arrows indicate the cause-and-effect relationship between the variables. Plus and minus signs at the arrow heads indicate if there is a positive or negative relationship between the variables, such as one variable causing an increase or decrease in the value of another. CLMs are used to study the structure of a complex system and the dynamic behaviors which arise. Powerful insights can be generated with CLMs through the representation of causal relationships among variables with feedback loops (Atkinson et al., 2015; Sterman, 2000). This study uses a CLM to qualitatively represent the important variables identified by the SEIPS model and to understand how to facilitate sustainability and scalability of the system with policy interventions.

RESULTS

The case study with TCC generated results from our models that describe the work system, processes, outcomes, and interactions among the system components. SEIPS models the TCC structure and the CLM describes how the interacting components lead to certain outcomes. These models were generated from observations and meetings with TCC stakeholders. Policy interventions are introduced to the CLM to observe potential system improvements.

SEIPS Model of the TCC

Using SEIPS, we aim to understand the work system from the perspective of the people performing tasks using tools in an environment within an organization and considering the context of the work. The TCC work system is outlined in Figure 1.

People. The client is the central focus of the TCC's operations and receive the direct benefit of the counseling services provided. Clients access the TCC through the satellite spoke sites located within their county of residence and may receive individual, couple, or group counseling via the telehealth technology. Counselors are doctoral student trainees and see the clients from the main hub at the University campus. These student counselors may also perform research activities, often using the TCC as their study site. Supervisors are licensed psychologists hired to provide one-on-one training and supervision to the counselors by reviewing session notes and recordings. Additional TCC staff include student workers who provide basic administrative support and service coordinators who receive referrals, schedule appointments, and perform client screenings.

Tasks. The care process at the TCC has clients entering the system through referrals. Clients can either self-refer by calling the clinic directly or a caregiver in their community can call or fax in a referral. Once the referral is received, a service coordinator schedules and performs a phone screening to determine eligibility of the client for service with TCC. Clients can be assigned to a counselor for the type of service they need, or if counselors are fully booked, the client is placed on a waitlist. Clients who prefer not to be seen via telehealth or require a greater level of care than weekly, outpatient services are referred out to another care provider. Types of services offered to clients at TCC include individual, couples, and group counseling. Clients can receive up to 20 sessions of individual or couples counseling and group sessions are offered over a set period of time (i.e. 4 weeks for smoking cessation group or 7 weeks for mindfulness group). If an individual does not show up or cancels too many appointments, they are considered to have dropped-out of service with TCC. These former clients can be referred to TCC again if they have not met the maximum number of sessions.

Technology. The TCC is equipped with telepresence technology to facilitate the remote counseling sessions. Within each counselors' room at the TCC hub they have internet-connected computer workstations with video cameras to host the sessions. The counselors' computers are equipped with an EMR software and connected to a printer to manage client records. At each satellite spoke site there is a television with audio/video conferencing equipment in a private room where the clients attend counseling sessions.

Environment. There are two environments used to deliver care in the TCC system; the client facing environment at the community spoke site, and the clinician's environment at the TCC hub. The spoke sites often host many service providers for residents including food pantries, rotating specialty clinics, and wraparound services for women, children, and families in the resource center sites and nurse and physician providers at the primary care sites. These community centers are located centrally within the service county, either geographically centered or in the most populous city. When a client comes in to the center for a session, they are greeted by staff and directed back to the private counseling room. The rooms contain the telepresence technology, a table and chairs. Materials that the client may need for the session, including homework and consent forms, are faxed or emailed and printed at the community center.

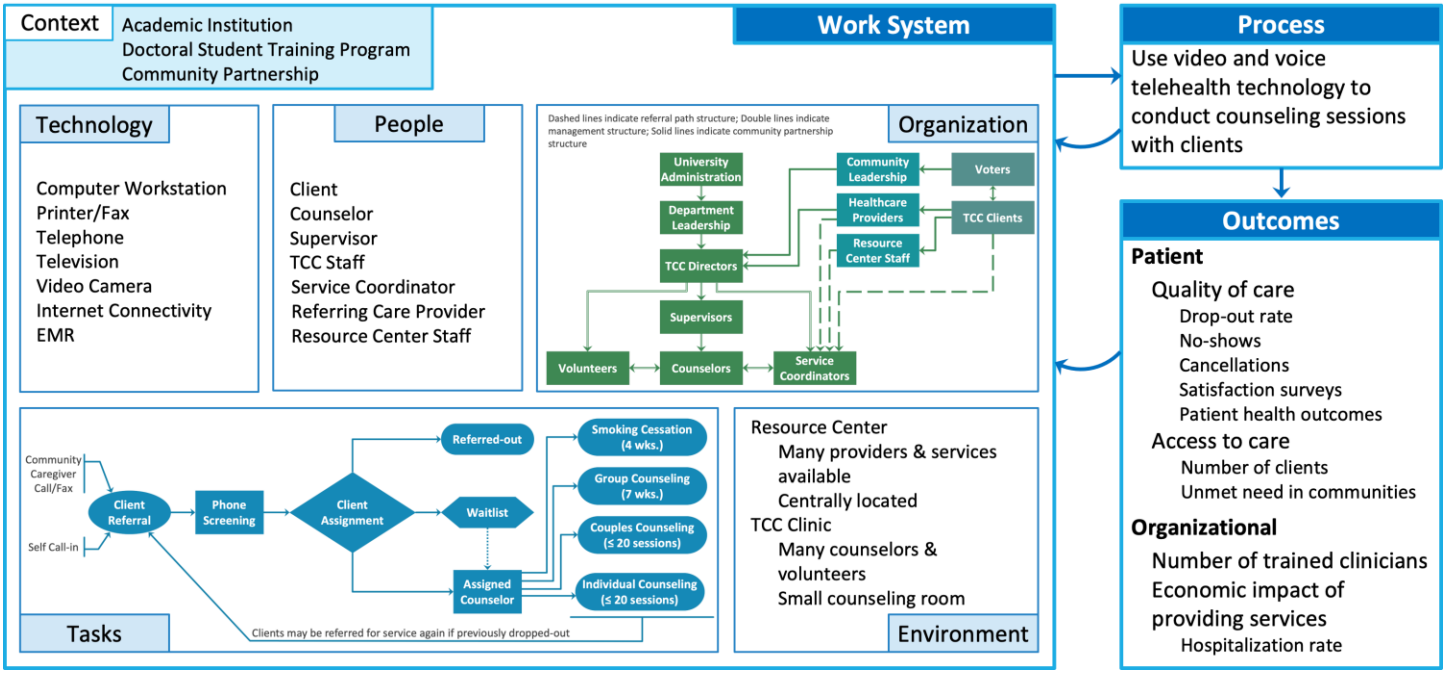

Figure 1. SEIPS model of the TCC care process

The TCC hub is located in a building on the Texas A&M Health Science Center Campus. There are several small private rooms within the TCC office where counselors can conduct sessions. Often there are more counselors than there are rooms so client scheduling must work within both of these capacity constraints. Staff of the clinic, including volunteers and service coordinators, work in a larger shared office with multiple computer workstations for scheduling, processing referrals, and performing research activities.

Organization. The hierarchical structure of the TCC includes three stakeholder groups; university employees, community professionals, and residents. The leadership group of the TCC starts with the directors, who oversee the clinical supervisors, volunteers, and service coordinators. All activity within the department is overseen by the department leadership and university administration, so the TCC directors report to these entities. Additionally, the TCC directors facilitate communication and receive feedback from community professionals, especially community leaders such as county judges and commissioners, and other healthcare providers. This care coordination network allocates resources to provide services within the community and more seamless care transitions for the clients.

Context. The context in which TCC offers services distinguishes the clinic from other mental healthcare providers. TCC operates within a large academic institution and is in large part funded by the University. Physical space, technology, and supplies to offer services are allocated from the academic department. Texas A&M University is able to offer a unique training opportunity for doctoral students in psychology programs. Field practicum experience is required for graduation from the program and can be obtained with placement into the TCC. Students accepted into TCC's advanced practicum tour the community centers at the start of the semester to gain better understanding of their clients' environmental context. Funding for the satellite spoke site technology and Internet connections are partially funded by grants and mostly funded by the county in which the center is located. Because of the integration within the communities where services are provided, community partnership is essential for the TCC's operation (Garney, McCord, Walsh, & Alaniz, 2016).

Process. The work system components enable the TCC to conduct its primary purpose; to use video and voice telehealth technology to conduct counseling sessions with clients.

Outcomes. Measuring the goals of the TCC process can be summarized by defining several key outcome metrics. In SEIPS, outcomes that are important to patients and the organization are assessed. For this case study, we consider the patient to include the TCC's clients and their community to provide a population health perspective on outcomes. The outcome metrics are outlined in Figure 1.

Causal Loop Model of the TCC

Results from the SEIPS model identify key system inputs, processes, and interactions to inform a CLM. Using an iterative modeling approach with input from the TCC stakeholder group, the CLM in Figure 2 was developed. There are two primary loops that describe the variables and interactions identified as important for the system's function. We walk through the CLM by describing the loops, variables, and interactions identified.

Begin by starting the balancing loop, in blue, with the variable "referrals to TCC." We see that the number of clients enrolled in TCC services after the phone screening has a positive relationship to the number of referrals; this means that

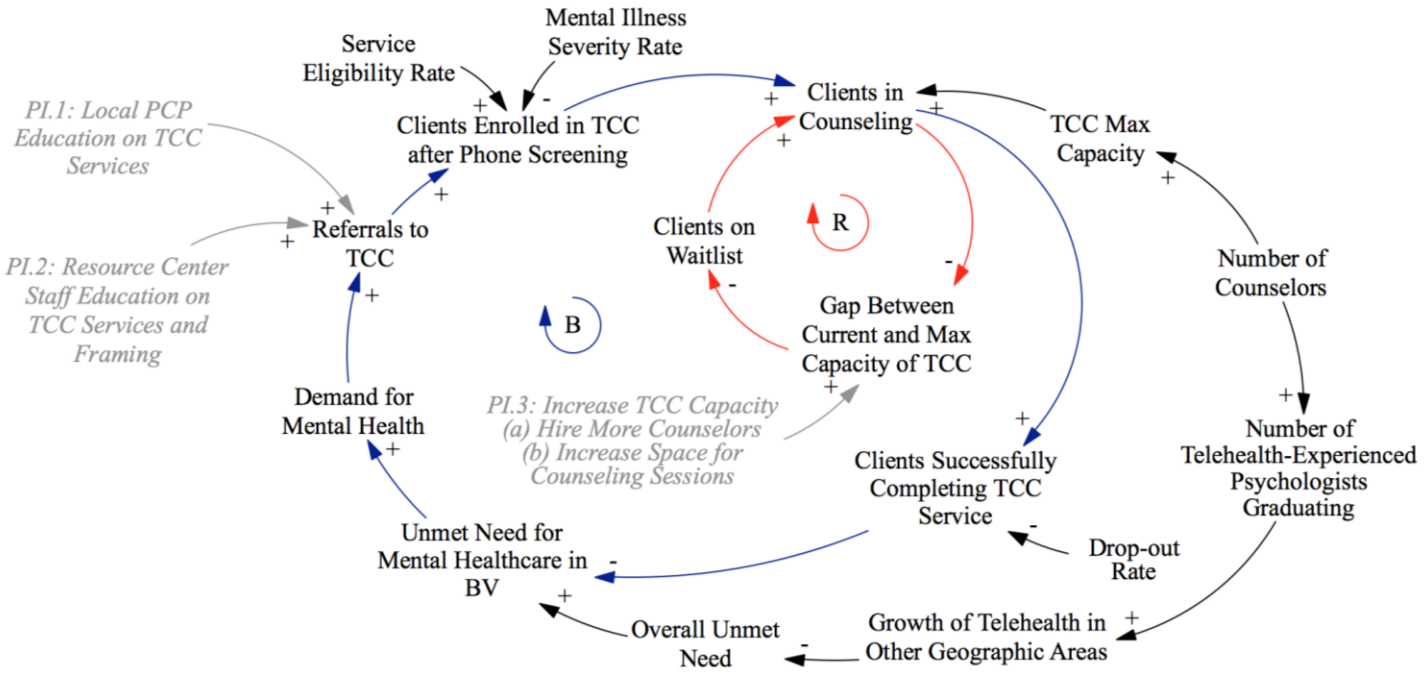

Figure 2. Causal Loop Model of the TCC system

with more referrals, we expect to have more clients enrolled. Enrollment is affected by how many potential clients are eligible for service and the severity of mental illnesses among potential clients. The more clients that are enrolled naturally leads to more clients in counseling where some number of those clients successfully complete TCC service. Clients who drop-out of service are not considered to successfully complete service so this rate negatively impacts the completion variable. As more residents of Brazos Valley (BV) become clients at TCC and successfully complete services, over time the need for mental healthcare in BV declines. This negative relationship continues to the next variable where demand for mental health services reduces and, on a longer timescale, the number of referrals to TCC, our starting variable, also declines. This balance in the relationship between variables demonstrates a natural equilibrium of supply and demand that occurs when healthcare services are available to a community.

A number of external factors play a role in dampening this oscillation, especially the number of counselors available. When the TCC reaches its maximum capacity because there are no more counselors available to see clients, the clients must be placed on a waitlist. Also, since the TCC is a doctoral student training program, the number of new psychologists trained in telehealth service delivery increases as these students graduate. This increases the potential growth of telehealth thereby enabling the reduction of unmet need for mental healthcare, especially in underserved rural areas such as the BV.

The second loop that emerges from the relationships between variables is a reinforcing loop, in red, caused by capacity constraints. We define a new variable to represent the changing difference between the current and maximum capacity of the TCC. As there are an increasing number of clients in counseling, this capacity gap shrinks until clients must be waitlisted until a spot opens in the TCC schedule. If the resource capacity is insufficient to serve as many clients as wish to use TCC's services, this loop creates an ever-increasing waitlist as demand surges.

This CLM highlights areas where policy changes could be applied to better meet the goals of the TCC and improve outcomes. Addressing the disparity in access to mental healthcare services in the BV is a primary goal for the TCC. Scaling up service delivery to meet the demand for mental healthcare in BV is one way the TCC can meet this goal. However, as more clients enroll for services, we observe that this system's inherent reinforcing loop creates a growing client waitlist. Three policy interventions are proposed in the CLM to aid these goals.

Policy interventions. From the CLM, three policy interventions emerge to address the goals and challenges of offering telebehavioral health using the TCC hub-and-spoke model. First, primary care providers for all health needs in the communities which TCC serves are sometimes aware of the unique telehealth service offered but no formal program has been established to engage with the community providers. Implementing the first policy intervention (PI.1 in Figure 2) aims to increase referrals through primary care. Second, upon learning through SEIPS modeling that there is no formal training provided to the resource center staff on discussing enrollment of services with community members, the policy intervention (PI.2 in Figure 2) to provide such training should also increase the number of people seeking referrals to the TCC. Finally, in considering the capacity constraints leading to the negative reinforcing loop of the client waitlist, policy intervention three (PI.3 in Figure 2) demonstrates how hiring more counselors, which also requires increasing the space available at the TCC hub for counseling sessions, will help balance the capacity gap.

DISCUSSION

At its current capacity, the TCC would not be able to serve all of the clients who wish to receive counseling through the clinic. This leads to a continually increasing waitlist and slower improvement in the disparity of mental healthcare access in the Greater Brazos Valley. Through offering service to more potential clients, the TCC is able to move closer to the goal of meeting the mental healthcare needs in the community.

Through using SEIPS and CLM techniques, we are able to identify system components that are key to the operation and scalability of the telebehavioral health program and identify policy interventions through analyzing the dynamics of the system components. Systems models, as presented here, allow decision makers the ability to holistically assess the relevant components of a system and view the relationships between the components and their effect on one another (Sterman, 2000). Applying policy interventions to a system can also be observed first through a systems model before deciding to implement the proposed changes.

The impact of this study is twofold: proposed changes to the TCC system are modeled to inform process improvement decision making, and the unique modeling approach where a systems dynamic model is grounded with a SEIPS model provides a new framework for evaluating systems. We note that the model is developed from a single-center study and therefore may not be generalizable to other academic-community partnerships. Additionally, this study allows for future work that incorporates a stock and flow system dynamics model to quantify the impact of the proposed changes.

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