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Tele-Psychiatry to Address Severe Persistent Mental Illness in Rural Communities: An Economic and Break-Even Analysis

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Abstract

Background: People living in rural communities experience significant barriers accessing mental health care, including a shortage of psychiatrists and other behavioral health specialists. Telemedicine has the ability to improve access for these populations by allowing psychiatrists in urban settings to treat rural patients over video. However, start-up costs may hinder implementation of new tele-psychiatry programs.

Materials and Methods: We created a model to estimate the point at which tele-psychiatry would financially break even based on estimates of improved access to outpatient care for people with schizophrenia and bipolar disorder. We demonstrate how our model can be used with an example of a tele-psychiatry program serving five rural Indian Health Services clinics in California.

Results: When reimbursement for psychiatric services provided over telemedicine is relatively low compared to reimbursement for hospitalization visits, changes in the ratio of hospitalizations to telemedicine visits have very little impact on required hospitalization improvement.

Conclusions: Tele-psychiatry programs are likely to break even within the first three years when providing psychiatry services to a rural community with a scarcity of mental health services. Our findings are important because they indicate that the cost of improving access to tele-psychiatry services is likely low compared to the potential cost savings associated with reduced hospitalizations for people with severe persistent mental illness.

Introduction

Schizophrenia and bipolar disorder are severe persistent mental illnesses (SPMIs) that are relatively common, with an estimated prevalence of 0.25%-0.64% and 2.8%, respectively[1,2]. Access to routine mental health care for patients with SPMIs has been shown to improve patient outcomes and quality of life and reduce the frequency of mental health crises that can lead to hospitalization[3]. However, many patients with SPMI are unable to receive mental health care for exacerbations and maintenance of care. These gaps in care contribute to loss of quality of life and billions of dollars in costs associated with SPMIs annually[4-6].

For people with SPMIs living in rural communities, barriers in access to mental health services are exacerbated[7-10]. There is a shortage of psychiatrists and other behavioral health specialists in most rural communities across the country, which is projected to worsen over the next decade[9,11-13]. Telemedicine for psychiatry, or telepsychiatry, has the ability to improve access to care by allowing psychiatrists typically located in urban settings to treat rural patients over video. Previous studies suggest that patients with SPMIs are receptive to receiving telepsychiatry services, particularly when barriers to in-person care exist[14-16]. There is also evidence that patients with SPMIs are more likely to complete telepsychiatry encounters than in-person encounters[15]. Finally, telepsychiatry offers a valuable opportunity for better care coordination by including additional members of the care team, including the primary care provider.

Despite the potential for telepsychiatry to improve outcomes among patients with SPMIs in rural communities, many rural clinics have not adopted telepsychiatry models of care. Start-up and maintenance costs are seen as major barriers to implementing and maintaining these services, particularly for small clinics. However, despite the costs of implementing telepsychiatry services, there is the potential to improve patient care and prevent or reduce hospitalizations costs through better continuity of care. Understanding the costs and benefits is important for payers of healthcare when making decisions regarding payment for telepsychiatry services. Towards this end, we conducted economic and breakeven analyses of telepsychiatry services, focused on the potential reduction of costs through decreased hospitalizations for mental health crisis resulting from an increase in access to telepsychiatry. Our study explores the circumstances under which the addition of a telepsychiatry program would be cost neutral with its additional costs offset by cost savings. We demonstrate the utility of this method using an example based on telepsychiatry services provided by UC Davis Health to five rural Indian Health Service clinics in California.

Materials and Methods

Analysis framework: A breakeven analysis describes when a course of action is cost neutral. For example, a breakeven scenario occurs when $320 worth of telepsychiatry cost has at least a 4% chance of avoiding $8,000 of psychiatric hospitalization cost. For the purposes of our economic analyses, we considered three core cost components derived from outpatient and inpatient costs: telepsychiatry outpatient visit costs; costs of hospitalization when telepsychiatry is used; and costs of hospitalization when telepsychiatry is not used. We assume that without telepsychiatry services, patients do not have access to in-person psychiatry services. Figure 1 shows the decision tree illustrating how expected costs accrue.

Calculating additional costs associated with telemedicine: The cost of telepsychiatry services is the sum of fixed costs to establish and maintain telepsychiatry services that does not vary based on use and variable costs

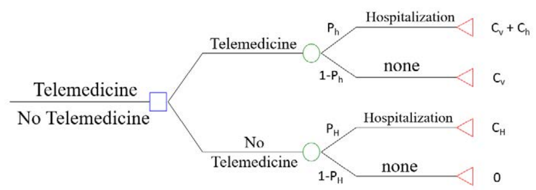

Figure 1: Decision tree framework for breakeven analysis.
Note: P indicates probability for hospitalization with h (for Telemedicine or TM) or H (for Usual Care or UC). C indicates costs for telemedicine (v) or hospitalization (h or H). $C_v = 0$ for Usual Care.

that occur with every telepsychiatry patient encounter. Whether to include telepsychiatry fixed costs in the analysis depends on the cost perspective selected since payers (health plans) may or may not be responsible for these costs. In our analyses, we consider both scenarios.

From a payer perspective, costs refer to the payment to the psychiatrist for each encounter and is meant to cover both variable and fixed costs. In our analysis, we focus on the conditions under which it makes sense for a healthcare payer to cover telepsychiatry services instead of usual care. For our "base case," we assume the payer does not cover the fixed costs to set up and maintain the telemedicine infrastructure, but as part of our sensitivity analyses, we consider a scenario where fixed costs are considered as well.

Calculating additional benefits (cost savings): We assume that those receiving psychiatric services will have lower costs associated with psychiatric-related hospitalization than those not receiving services. To compute the total costs for telepsychiatry services and hospitalizations, one must consider quantity of use, which is determined by the probability of use and the quantity of use for those who use.

Conceptualization of breaking even: To draw conclusions from the economic analysis, the key issue is whether the overall expected costs of telepsychiatry is less than the expect cost of usual care (i.e., no telepsychiatry). The intuition behind when this occurs is illustrated with people labeled as *A* and *B* and *C* in Figure 2. There are two types of patients who will not experience the reduced hospitalization that drives the economic attractiveness of telepsychiatry. The first group are patients who were never at risk for hospitalization. They do not have preventable hospitalizations because they are not in need of care. Spending money to provide telepsychiatry to this group of people labeled *A* will not prevent preventable hospitalizations. On the other hand, group *C* are people who have a condition that will lead to hospitalization but the telepsychiatry intervention as it is currently configured will not prevent the hospitalization (i.e., they are the hospitalized people in both the usual care and the telepsychiatry scenarios). In contrast, it is the patients in group $\mathcal{B}$ who represent the greatest opportunity for cost reductions. These people, through access to telepsychiatry services, experience reduced hospitalization costs (e.g., either through reduced likelihood of use or less intensity of use). The overall cost question revolves around whether the costs savings from group $\mathcal{B}$ covers the costs of providing telemedicine access to people in groups $\mathcal{A}$ and $\mathcal{B}$ and $\mathcal{C}$.

Derivation of the breakeven condition: To calculate the overall expected cost impact of switching from usual care to telepsychiatry, one calculates expected costs for each option. Expected values are computed with probabilities. Table 1 shows the probabilities and the costs we use to compute the expected additional costs (from telepsychiatry costs) and the expected additional cost savings (from less hospitalization costs). When the costs for treating a group of N people with telemedicine (TM)

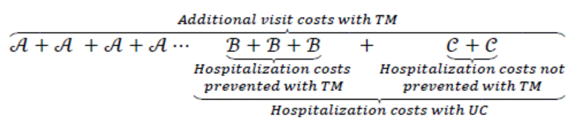

Figure 2: Illustration of the two options (telemedicine and usual care) using three types of people ($\mathcal{A}$, $\mathcal{B}$, and $\mathcal{C}$).
Note: Type $\mathcal{A}$ people are never at risk for hospitalization. They do not have preventable hospitalizations. In contrast, type $\mathcal{C}$ people have a condition that will lead to hospitalization but the telepsychiatry intervention as it is currently configured will not prevent the hospitalization However, people in group $\mathcal{B}$ represent those who through access to telepsychiatry services experience reduced hospitalization costs (e.g., either through reduced likelihood of use or less intensity of use).

equal the costs for treating the same N people with usual care (UC), this defines the breakeven point:

$\text{Total Cost}_{TM} = \text{Total Cost}_{UC}$, or

$\text{Total Hospital Cost}_{TM} + \text{Total TM Visit Costs} = \text{Total Hospital Cost}_{UC}$.

Case study: UC Davis Telepsychiatry Services to Indian Health Services Clinics: To conduct the breakeven analysis for telepsychiatry, we used a set of estimates based on assumptions from both previous literature and our telepsychiatry program data. Table 2 shows these "base case" assumptions. Estimated average hospitalization costs were calculated using the proportions of patients with schizophrenia (44%) and bipolar disorder (56%) from the sample of UC Davis telepsychiatry patients that had one of these diagnoses. We assume average lengths of stay of 10.7 days for schizophrenia and 7.7 days for bipolar disorder, as reported by the Healthcare Cost and Utilization Project (HCUP)[17], and corresponding hospitalization costs of $8,683.82 for schizophrenia and $6,746 for bipolar disorder. The weighted average cost of a hospitalization is $7,599 (0.44 × $8,683.82 + 0.56 × $6,746 ≈ $7,599).

The estimated cost to establish telepsychiatry services ($7,550) includes a mobile medical cart with power, a computer, a touch monitor, a pan-tilt-zoom camera, a microphone with speaker, hardware, and accessories. An annual Zoom license and ongoing support and hardware updates is estimated at $1,750 per year. We estimate the average payer cost (payment) of a telepsychiatry encounter to be $160, based on Medicare non-facility reimbursement rates for the Sacramento area.

Table 1: Probabilities, costs, and expected costs

	Telemedicine (TM)		Usual Care (UC)	
	Hospitalization (h)	**No Hospitalization**	**Hospitalization (H)**	**No Hospitalization**
Sample size (N)	$n_{with\ h}$	$N - n_{with\ h}$	$n_{with\ H}$	$N - n_{with\ H}$
Probability	$P_h = n_{with\ h} / N$	$(1 - P_h) = (N - n_{with\ h}) / N$	$P_H = n_{with\ H} / N$	$(1 - P_H) = (N - n_{with\ H}) / N$
Averages				
Hospitalizations, among those hospitalized	$h / n_{with\ h}$	0 hospitalizations	$H / n_{with\ H}$	0 hospitalizations
Hospitalizations overall	h / N	0 hospitalizations	H / N	0 hospitalizations
Reimbursement				
Hospitalization	R_{hosp}	$0	R_{hosp}	$0
TM	R_{TM}		$0	
Totals				
Hospitalizations	$h = N \times P_h \times h / n_{with\ h}$	0 hospitalizations	$H = N \times P_H \times H / n_{with\ H}$	0 hospitalizations
TM visits	$Visits_{TM} = N \times Visits_{TM} / N$		0 telemedicine visits	
Costs				
Hospitalization	$C_h = h \times R_{hosp}$	$0	$C_H = H \times R_{hosp}$	$0
TM visits	$C_v = Visits_{TM} \times R_{TM}$		$0	
Expected total costs	$C_h + C_v = N\ P_h \times h / n_{with\ h} \times R_{hosp} + C_v$		$C_H = N \times P_H \times H / n_{with\ H} \times R_{hosp}$	

NOTE: Costs are indicated with C; Probability with P; reimbursement with R, visit with V, and hospitalization with h (for Telemedicine or TM) and H (for Usual Care or UC). Total number of people is indicated with N and total hospitalized with n. N with h refers to the number of patients who experience a hospitalization in the telemedicine group. N with H refers to the number of patients who experience a hospitalization in the usual care group.

Table 2: Base case assumptions and calculations for the breakeven analysis

		Key calculations		
Variable Description (symbol)	**Values (source)**	**κ**	**η**	**ψ = κ/η**
Population				
People with severe and persistent mental illness (N)	64 (Tele-AIMI)			
Costs per unit				
Telemedicine visits (R_{TM})	\$160 (Tele-AIMI)			
Hospitalization (R_{hosp})	\$7,599 (HCUP)	\$160 / \$7,599 = 0.021	16/125 = 0.128	0.021/0.128 = 0.164
Expected use per patient				
Telemedicine visits ($Visits_{TM}$/N)	125/64 = 1.95 (Tele-AIMI)			
Hospitalizations (h/N)	16/64 = 0.25 (assumption)			

Note: $\kappa = R_{TM} / R_{hosp}$ and $\eta = h / Visits_{TM}$, where N is the number of people with severe and persistent mental illness; R_{TM} is the reimbursement for a telemedicine visit; R_{hosp} is the reimbursement for a hospitalization; h is the number of hospitalizations under telemedicine; and $Visits_{TM}$ is number of telemedicine visits. Tele-AIMI is the California-based tele-psychiatry program on which base case assumptions are made. HCUP is the Healthcare Cost and Utilization Project, a collection of longitudinal hospital care data in the United States.

Results

Table 2 provides base case values for payment rates, hospitalization payment rate, expected number of hospitalizations, and expected number of telepsychiatry visits. Table 2 also shows the calculations for the payment ratio. The ratio of 0.164 clarifies the requirement that the percentage change in expected hospitalization without telepsychiatry must be at least 0.164. In other words, there must be at least 1.164 times more hospitalizations with usual care than with telepsychiatry care.

In the base case, there are 16 hospitalizations with telepsychiatry, so usual care must have at least 18.6 hospitalizations for the telepsychiatry model of care to reach the breakeven point. These results are easy to confirm by computing the expected cost for usual care of 18.64 hospitalizations × \$7,599 = \$141,584 and comparing this to the expected costs for telepsychiatry, 16 hospitalizations × \$7,599 = \$121,584 plus telepsychiatry visit costs of 125 visits × \$160 = \$20,000 for a total that equals the expected cost of usual care.

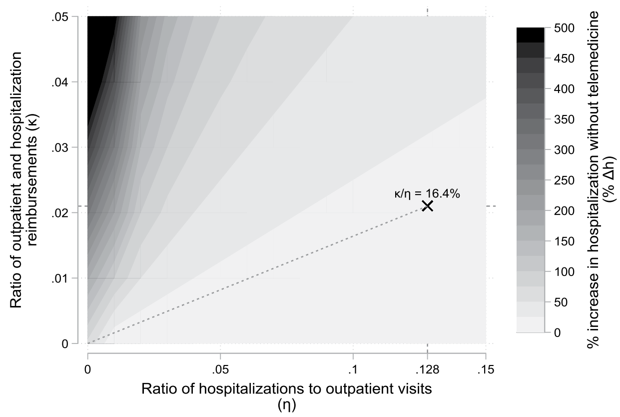

Figure 3: Sensitivity analysis illustrating different breakeven situations. Results using the base case model inputs for κ (the ratio of reimbursements for telemedicine visits and hospitalizations) and η (the ratio of hospitalizations to telemedicine visits) are represented by the "X", which indicates that telemedicine will do better than breakeven if %Δh (the percentage increase in hospitalization without telemedicine) is greater than 16.4%.

Figure 3 presents the results of a sensitivity analysis illustrating other breakeven situations. If the percentage change in expected hospitalization without telepsychiatry is greater than 25%, telepsychiatry will more than pay for itself. The cost ratio, as shown in Figure 3, is 0.021/0.128 = 0.164, which is the requirement for the telepsychiatry program to break even in the base case scenario.

The required amount of the cost ratio can be sensitive to different assumptions. For example, when payment for telepsychiatry is relatively low compared to payment for hospitalization, changes in the ratio of hospitalizations to telepsychiatry visits have very little impact on the required improvements in hospitalization reduction. Figure 4 illustrates this in the lower part of the contour plot. The dashed lines that run along most of the values for η (the ratio of hospitalizations to telemedicine visits) have very little slope for small values of κ (the ratio of reimbursements for telemedicine visits and hospitalizations). In contrast, for higher values of κ (e.g., κ = 0.05), the required percentage increase in hospitalization without telemedicine is very sensitive to changes in η. This is evident in Figure 4 with a rapidly declining dashed line at κ = 0.05; the required %Δh for a breakeven result varies from 500% to 17% as η varies from 0.01 to 0.3, with most of the required increase in %Δh (i.e., from 50% to 500%) coming as η declines from 0.10 to 0.01.

Figure 4 also shows that when the ratio of hospitalizations to telepsychiatry visits is relatively high (e.g., 0.30), changes in relative payment ratio have very little impact on the required reduction in hospitalization associated with telepsychiatry. Figure 4 illustrates this in the rightmost part of the contour plot. In contrast, for

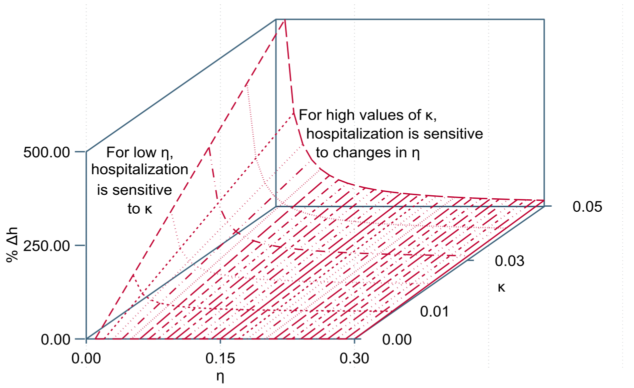

Figure 4: An illustration of different breakeven conditions that clarify the sensitivity of requirements for %Δh (the percentage increase in hospitalization without telemedicine) based on assumptions about κ (the ratio of reimbursements for telemedicine visits and hospitalizations) and η (the ratio of hospitalizations to telemedicine visits).

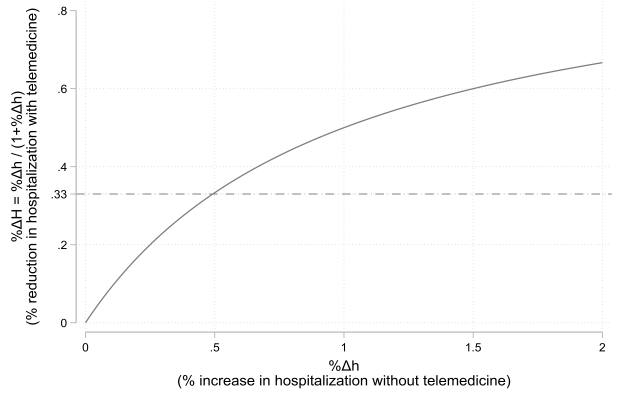

Figure 5: Converting %Δh (a percentage increase going from telemedicine to usual care) into %ΔH a percentage reduction in hospitalization going from usual care to telemedicine. A requirement of %Δh = 50% is equivalent to a %ΔH = 33% reduction in usual care's hospitalizations.

very small ratios of hospitalizations to telepsychiatry visits, the breakeven points is much more dependent on the required reduction in hospitalizations associated with telepsychiatry. This is evident in Figure 4 with a rapidly increasing dashed line at η = 0.01; the required %Δh for a breakeven result varies from 0% to 500% as κ varies from 0 to 0.05.

As noted earlier, it can be more intuitive to think of assumptions about the percentage *decrease* in hospitalizations when switching from UC to TM (i.e., %ΔH) rather than %Δh, the percentage *increase* in hospitalizations when switching from TM to UC. Figure 5 converts %Δh (using telemedicine as the basis for percentage change) into %ΔH a percentage reduction in hospitalization using usual care as the starting point. For example, if the breakeven requirement was %Δh = 50%, and if one expects H = 100 hospitalizations with usual care, what does that %Δh requirement mean? Figure 5 answers this question. The horizontal axis maps %Δh to the percentage reduction from the usual care value on the vertical axis (i.e., %ΔH). For the case of %Δh = 0.5, one would need a 33% reduction from usual care's hospitalizations. Thus, if one expects 100 hospitalizations with usual care, one needs telemedicine hospitalizations to be at least 67, a reduction of 33 hospitalizations. For our base case scenario, the required %Δh = 0.164 translates into a %ΔH = 0.141 reduction in the hospitalizations seen in usual care. Figure 5 also shows that for situations where %Δh = 1, the required %ΔH = 0.5.

In a scenario analysis, we consider a healthcare payer who must cover the fixed and variable costs described in equation (1). For the Tele-AIMI program, this involves $7,800 in telemedicine set up costs in addition to $1,750 annually for telemedicine maintenance. This total fixed cost amounts to $9,550. The addition of fixed costs into the calculations changes the breakeven condition from

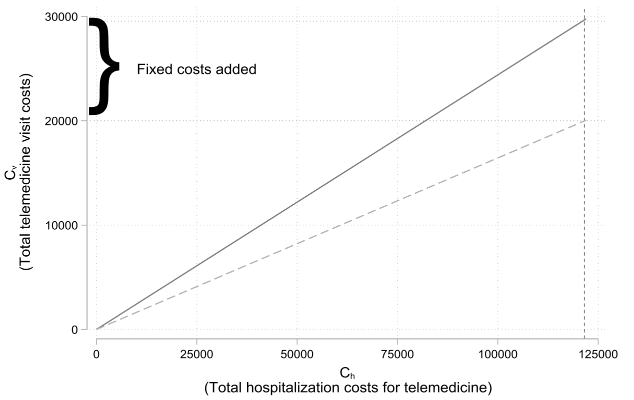

Figure 6: The slopes of the rays from the origin indicate the required %Δh (a percentage inc1rease in hospitalizations when switching from telemedicine to usual care) to break even. When fixed costs are considered (the solid ray from the origin), the slope of the line is steeper, meaning more impact on hospitalization is required for telemedicine to break even.

%Δh = C_v / C_h to %Δh = (FC + C_v) / C_h. Now, telemedicine must be slightly more economically attractive to cover additional fixed costs. Table 3 shows the calculations to compute the breakeven %Δh as $9,550 / $121,584 + $20,000 / $121,584. The first part equals 0.07855 and is the additional performance improvement above and beyond the required 0.164 that is now needed to cover the fixed costs. Figure 6 illustrates the impact of considering fixed costs. The slopes of the rays from the origin indicate the required %Δh in order to break even. When fixed costs are considered (the solid ray from the origin), the slope of the line is steeper, meaning more impact on hospitalization is required for telemedicine to break even. The dashed ray from the origin has a slope of %Δh = 0.164 (with C_v = $20,000 and C_h = $121,584). By adding FC = $9,500 to the breakeven calculations, the ray from the original is rotated

Table 3: Scenario analysis based on the Tele-AIMI trial

		Key calculations		
Variable Description (symbol)	**Tele-AIMI values**	**C_v**	**C_h**	**FC / C_h**
Total number of patients with severe mental illness receiving care	64	125 visits × $160 = $20,000	16 hospitalizations × $7,599 = $121,584	$9,550 / $121,584 = 0.07855
Costs – Fixed				
Set up	$7,800			
Maintenance per year	$1,750			
Total – Fixed Cost (FC)	$9,550			
Costs – Variable				
Telemedicine psychiatric outpatient visit (R_{TM})	$160			
Hospitalization (R_{hosp})	$7,599			
Visits				
Expected telemedicine visits ($Visits_{TM}$)	125			
Expected hospitalizations with telemedicine (h)	16			

Note: C_v = Total cost of telemedicine visits; C_h = Total cost of hospitalizations with telemedicine; FC = Fixed Costs for telemedicine.

up with a slope that is then steeper by 0.07855. Thus, %Δh considering fixed costs equals 0.243, or 0.07855 more than when fixed costs were not relevant. The %Δh = 0.243 breakeven point can be converted to a %ΔH ≈ 0.20 breakeven requirement. Using the numbers from the AIMI example, this means that instead of reducing hospitalizations from H = 18.63 to h = 16, the reduction in hospitalizations must be equal to (-0.20 + 1)×18.63 = 0.80×18.63 ≈ 14.904. By including fixed costs in the calculations, hospitalizations must be reduced by about one more.

Discussion

Our results suggest that tele-psychiatry programs can be cost effective even assuming small improvements in hospitalizations. Only when annual costs of outpatient treatment is similar to the cost of hospitalization will a tele-psychiatry program need to be very effective at reducing hospitalization to break even. As shown in Figure 3, for low values of κ (e.g., when the reimbursement ratio of outpatient visits to hospitalization visits is 0.01), changes in η (i.e., the ratio of hospitalizations to outpatient telemedicine visits) have very little impact on required hospitalization improvement (%Δh). In contrast, for higher values of κ (e.g., κ = 0.05), the required %ΔH is very sensitive to changes in η. Because the cost of hospitalization will likely remain much greater than the cost of outpatient psychiatry visits, it is thus likely that tele-psychiatry programs will break even under these assumptions.

Our findings are important because they indicate that the cost of improving access to tele-psychiatry services is likely low compared to the potential cost savings associated with reduced hospitalizations for people with SPMI. Our analyses suggest that the Tele-AIMI program, which has expanded access to care for American Indian patients living in rural areas, has most likely reached the breakeven point based on conservative estimates of the impact of the program on reduced hospitalization. Our model adds to the telemedicine literature by demonstrating how decision makers could apply a simple approach to estimate the breakeven point for a new tele-psychiatry program using their own assumptions. A key strength of our approach is that it allows users to identify the breakeven point of a hypothetical program based on their own perspectives on how much the program will increase access to outpatient care and how valuable this increased access to outpatient care is in terms of reducing hospitalizations.

Previous studies have shown tele-psychiatry to be an effective low-cost option for providing access to mental and behavioral health care in rural areas. A recent study comparing telepsychiatry to two other modes of delivering care to rural areas found that telepsychiatry was the least expensive option[18]. Other studies have found similar results, including for programs aimed at serving tribes[19-21]. Our study findings add to the body of literature demonstrating the economic utility of offering telepsychiatry services to patients living in remote and rural areas of the country. Additionally, as noted in a recent scoping review, cost analyses for telehealth programs have too often been program-specific, limiting the generalizability of findings to other settings[22]. For this reason, we attempted to present a model that can be utilized in different settings and that can be varied to reflect different perspectives of the impact of telehealth on both access and effectiveness.

Our study has several limitations. First, our model is based on patients with schizophrenia and bipolar disorder, conditions associated with high rates of hospitalization and emergency department utilization. We assumed a percentage of patients with SPMI based on the Tele-AIMI program. Thus, our breakeven scenarios may not be generalizable to populations with a very low mental health burden. Second, our model assumes that patients do not have access to local psychiatric services. Our model would therefore not be applicable to a new tele-psychiatry program that provides an alternative mode of care for patients already receiving routine outpatient care. Third, we did not have access to hospitalization or other outcome data from the Tele-AIMI program; therefore, our breakeven analysis for this example is purely hypothetical based on the program population. Additional data on outcomes would help to improve understanding of the variation in the impact of telepsychiatry programs on outcomes. Finally, our model does not take into account the other important benefits of improving access to psychiatric care for people living in rural communities. Tele-psychiatry programs have the potential to improve quality of life for patients with SPMI as well as patients with other common conditions such as depression and anxiety. An in-depth cost effectiveness analysis focused on these other important outcomes would provide a more holistic view of the cost-benefit equation for decision makers considering implementation of a tele-psychiatry program.

Conclusions

Despite its limitations, our study is useful for helping implementers to determine the likely point at which a tele-psychiatry will break even. Our model is flexible, allowing users to vary the extent to which telemedicine will increase access and the extent to which access will reduce hospitalizations due to mental health crises. Importantly, our study also demonstrates that tele-psychiatry is likely to break even within the first three years when providing psychiatry services to a rural community with a scarcity of mental health services.

Conflict of Interest

The authors have no competing financial interests in relation to the work described.

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