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COST-EFFECTIVENESS OF COLLEGIATE RECOVERY PROGRAMS

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PREFACE

Recovering from a substance use disorder is challenging, and there are fewer environments more challenging than a college campus. Since the late 70s and early 80s college campuses have been experimenting with programs to build communities of support for students in recovery from addiction, but growth has been slow and haphazard. Similarly, slow and haphazard growth among recovery community organizations and other peer-based recovery support services have begun to build a backbone of recovery infrastructure across the country. Many factors contribute to stymied growth of these promising programs, but chief among them is the patchy evidence base for the efficacy and efficiency of these programs. This thesis represents an attempt to begin to fill one such gap, and to provide an additional tool for advocates and decision-makers, as well as those seeking guidance on how to improve efficiency in existing programs.

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The prevalence of substance use disorders (SUDs) is greater among full-time college students and young adults regardless of enrollment status than it is among any other age group (1,2). These disorders represent substantial costs to both society and to institutions of higher education, both in terms of life years lost and in lost tuition revenue. The recent proliferation of collegiate recovery programs (CRPs) – supportive communities and resource centers for students seeking to maintain SUD recovery while pursuing a higher education – have the potential to help ameliorate some of these costs. While these CRPs are typically low-cost compared to acute care, a cost-effectiveness analysis of these programs has not yet been undertaken. In a comprehensive cost-effectiveness analysis, these programs were found to be cost-effective by the standards of the cost-effectiveness reference case from the societal perspective, and in line with the cost-effectiveness of other college health and wellness programs from the institutional perspective (3,4). In addition to being cost-effective, CRPs represent a cost savings to society and institutions across a wide range of variation.

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Literature Review

Prevalence of Substance Use Disorder Among College Students

Substance use disorder (SUD) represents a pressing public health concern, with an estimated 19.7 million Americans (7.2% of the population) affected (2). The prevalence of this condition is higher among young adults (18 to 25 years old) than in any other age group, with young adult prevalence at 15.1%, nearly double the national prevalence (7.5%), more than double the prevalence among adults over 26 (6.6%), and more than triple the prevalence among adolescents (4.4%) (5). The 5.2 million young adults with a SUD represent 25.8% of the total population of individuals with SUD (2).

In the US, 45,296 died in 2016 as a direct result of SUD (6). Those lives lost translated to 1,872,646 years of life lost, and over 4.8 million disability adjusted life years in 2016 (6). The overall costs to society of SUD are $442 billion annually (7–9). In addition to the substantial toll of SUD, drug overdose fatalities rose to a record high of 70,237 in 2017, largely driven by the continuation of the opioid public health emergency (10). SUD is particularly prevalent among American Indian or Alaska Native populations (12.8%) and those who identify as belonging to two or more races (9.7%), while the greatest number of SUD cases are among non-Hispanic Whites at 13.1 million (1).

Over half of American adults (58.9%) have attended some college or more (11), and many (40.5%) young adults are enrolled in college every year (12). The college environment can be particularly challenging for those who struggle with substances, especially for those who meet the criteria for SUD. Among 18 to 22-year old undergraduate students who were enrolled full time in college, 14.7% met the criteria for substance use disorder in 2016 (13). Prevalence was slightly higher among 18 to 22 year old young adults who were not enrolled in college at 15.1% (13).

Of particular concern is the gap between perceived substance use and actual substance use among college-aged peers. Undergraduates believe that over 93% of their peers drank alcohol in the last 30 days, when in reality only 58.9% did (14). This disparity was even more pronounced for marijuana use: undergraduates believed that 83.5% of their peers consumed marijuana in the past 30 days, but only 18.1% did (14). This disparity between perceived substance use patterns and actual substance use patterns can lead a college student struggling with SUD to resist seeking help, to normalize problematic substance use, or to experience feelings of isolation when pursuing recovery (15). When only 7.2% of young adults who need SUD treatment receive it (16), removing some of the barriers to seeking and receiving help is essential, and there is high potential to reach these individuals on college campuses.

Collegiate Recovery Programs

Collegiate recovery programs (CRPs) developed to aid college students in or seeking recovery from SUDs by providing social support and access to recovery-supportive resources. These programs are housed on college campuses, typically as part of health or counseling services, or within student affairs divisions (17). CRPs consist of four components: a community of students in recovery from addiction, recovery-supportive programming (e.g. peer support meetings, sober social activities, service work), and a dedicated space supported by dedicated staff, which is often limited to one or two full-time employees (18,19). Process evaluation studies of CRPs have found a variety of practices, including core functional activities that fall into the four key components described above, as well as additional practices that reflect campus cultural variation (17).

Outcome evaluation studies demonstrate that students currently in CRPs experience lower relapse rates (8%) than the general population in SUD recovery (40-60%), and the lower relapse rates are preserved among alumni of these programs (10.2%), as well (20–22). In addition to their core function of supporting individual students in recovery, these programs typically serve as educational resources, as well, aiming to shift the norms around substance use on college campuses, potentially easing barriers to help-seeking for young adults struggling with SUDs (18,23).

While CRPs have existed since the late 1970s, the recent rapid growth of the field from approximately 29 programs in 2012 to over 184 programs in 2018 has resulted in a significant gap between the popularity and proliferation of these programs, and the evidence of their support, though what evidence exists is promising (17,18,20,21). The literature on CRPs represents only part of the evaluation hierarchy. The evaluation hierarchy is a framework for understanding the critical components necessary to plan, implement and assess effective programs, with needs assessment forming the bottom tier, followed by an assessment of program design and theory, program process and implementation, and program outcome or impact (24). An assessment of program cost and efficiency forms the final tier of the evaluation hierarchy (24). To date no efficiency evaluations of CRPs have been conducted. Efficiency evaluations are critical for both policymakers and higher education administrators to decide whether these programs are a sound investment for their state or institution.

It is expected that these programs will be cost-effective, even when future benefits are discounted to account for the young age of the target population, because CRPs can be operated relatively inexpensively (19). The production function of CRPs is to facilitate peer support, and thus many of the most critical functions – peer support meetings, sober social activities, etc. – are driven by the students in recovery, themselves. Other peer support-based programs, such as Texas' Peer Recovery Support Services demonstration project, have provided extensive cost savings by reducing hospitalizations, involuntary admissions and readmissions for individuals with either SUDs, mental health conditions, or both (25,26). It is expected that CRPs will prove to be similarly cost-effective and lead to substantial savings both for society and institutions of higher education.

Public Health Significance

Treatment of SUDs is costly. Each treatment episode is estimated to cost between $15,227 and $22,436 in 2006 and 2010 dollars adjusted for inflation (27–29). Over 63% of individuals admitted for substance use disorder treatment in 2015 had at least one previous treatment episode, and 15.5% had five or more previous treatment episodes, thus it is critically important to improve recovery support and relapse prevention infrastructure to reduce the amount of repeat treatment episodes (30).

Relapse rates for the general SUD population are between 40% to 60%, which is comparable to other chronic diseases such as type 1 diabetes (30% - 50%) and hypertension or asthma (50% - 70%), though this relapse rate does not account for those who may return to substance use, but at levels that do not meet the criteria for SUD (22). Relapse rates among CRP participants are much lower, in contrast, at only 8% on average (range 0% - 25%), and these lower rates are maintained among program alumni (20,21). The protective effects of participating in peer-based recovery support in a naturalistic, community setting has also been observed in peer recovery support services and for adolescents in recovery high schools, thus there are multiple lines of evidence – some emerging, some well-established – supporting the efficacy of peer-based recovery support services delivered in a variety of settings (25,31). With treatment costs continuing to rise, a rise in mortality risk upon relapse due to the infiltration of powerful synthetic opioids into street drugs, it is particularly important to provide cost-effective recovery support resources in the communities and institutions where people in recovery may be most challenged (32). Due to outsized perceptions of substance use prevalence on college campuses described above, college campuses may be among the most challenging environments for people in recovery from SUD, as well as one of the most important opportunities for early intervention and secondary prevention due to the generally young age of college populations (14).

Much of the existing literature on CRPs are descriptive studies or outcome evaluation studies, and may use traditional SUD outcome metrics such as relapse rates, comparable college health statistics, or recovery capital (20,21,33,34). To date, no efficiency evaluation studies of CRPs exist in the published literature, thus a cost-effectiveness analysis is needed to provide context to the promising health outcomes described in other studies.

The threshold for cost-effectiveness from the societal perspective is by convention set at $50,000 per quality-adjusted life year (QALY) added by the intervention in question, but the origins and continued utility of this threshold is in question (35,36). Current recommendations from the Second Panel on Cost-Effectiveness in Health and Medicine call for thresholds to be tied to comparable treatments that can best be understood by decision-makers (4). In this case, the threshold for comparison can be set at treatment as usual (TAU), or the cost of additional treatment episodes, wherein college students attend treatment off-campus and do not participate in a CRP. It may also be useful to compare the cost-effectiveness of CRPs to the cost-effectiveness of other college health programs for the institutional perspective. For example, the cost-effectiveness of Hepatitis A/B vaccinations for college students is considered cost-effective at $8,500 per QALY (37). From the institutional perspective, the cost per student retained who would otherwise have been lost to substance-use related attrition is the effect or outcome of interest, rather than QALY.

Objectives

The purpose of this study is to determine whether CRPs meet the criteria for cost-effectiveness described above. A secondary objective of this study is to design and disseminate a Cost-Effectiveness Toolkit for CRPs based on this comprehensive analysis that will allow advocates to conduct their own basic cost-effectiveness analysis of an existing or proposed CRP.

METHODS

The reference case described by the First and Second Panel on Cost-Effectiveness in Health and Medicine provide a standard framework and methodology for conducting cost-effectiveness analyses from the perspective of society and the healthcare system (3,4). For the cost-effectiveness analysis of CRPs from the societal perspective, the analysis will follow the reference case guidelines; however, some adjustments must be made for the analysis from the institutional perspective.

Study Design

Cost-effectiveness analysis involves the calculation of an intervention's costs per unit of desired health outcome gained. The cost under a TAU scenario is subtracted from the cost under the intervention condition, in this case the cost of providing a CRP at an institution of higher education (3). This net cost is then divided by units of desired health outcome gained by the intervention, or the intervention's effect (3). This general cost-effectiveness formula is presented in figure 1.

Figure 1. The general cost-effectiveness formula.

$$\frac{Cost\ of\ Intervention - Cost\ of\ Treatment\ as\ Usual}{Intervention\ Effect - Treatment\ as\ Usual\ Effect}$$

In the case of a traditional cost-effectiveness analysis from the societal perspective, the desired health outcome is quality-adjusted life years (QALYs) gained, which are used in this study as the outcome of interest for the societal perspective model (3). The Second Panel on Cost-Effectiveness recommends examining cost-effectiveness from both the perspective of society and from the perspective of the healthcare system (4). Here, college and university campuses are substituted for the healthcare system perspective, as the burden of adopting CRPs as an intervention lies with these institutions. From this institutional perspective, the outcome of interest selected is the number of students retained who would otherwise be lost to substance use-related attrition. The costs to key campus resources and tuition lost to substance-related attrition represent the costs under the TAU scenario. Univariate and multivariate sensitivity analyses were conducted to account for uncertainty in both the societal and institutional perspective models (3).

Study Setting

Data on costs associated with CRPs were gathered from two national surveys of CRP staff and administrators conducted in 2015 and 2017, and used with permission of the authors (17,19). Of the 54 schools involved in the study by Jones and colleagues, 53 were located within a 4-year college or university, while one was categorized as a 2-year junior or community college (19). Most (81.5%) of the schools were public universities, while the rest (18.5%) were private (19). The Transforming Youth Recovery survey identified 184 institutions offering a CRP; however, data on type of college or university (e.g. public, private, 2-year, 4-year) were not collected (17).

Both surveys were cross-sectional in nature, and relied on self-reporting from CRP staff (17,19). Validity and reliability analyses were not reported for either survey instrument. The survey conducted by Jones and colleagues was limited to institutional members of the Association of Recovery in Higher Education, the national professional organization for CRPs, while the Transforming Youth Recovery survey was administered to the organization's grantees, recipients of technical assistance, and others identified as potentially having recovery support on campus (17,19).

Outcomes data on CRPs were drawn from a national cross-sectional study of CRP student participants (n = 486, programs represented = 29) conducted in 2012 by Laudet and colleagues, which reports average relapse rates along with relapse rate ranges for responding programs (20). Additional data sources for both the societal and institutional perspectives were drawn from the existing literature and are described below, and in tables 1 and 2.

Data Collection

Estimating Costs

From the societal perspective, the total cost to society of SUD was found in the *Surgeon General's Report on Alcohol, Drugs, and Health*, and is estimated to be $442 billion (7–9). To capture only the portion of societal costs attributable to college students with SUD,

Table 1. Variables for the CRP CEA societal perspective model.

Variable	**Description**	**Source**
C	The portion of the total financial cost to society of SUD attributable to full-time undergraduate college students aged 18-22.	(1,7–9)
C_i	Cost of SUD per individual in the target population.	(1,7–9)
B	CRP budget	(19)
M	Mean CRP membership	(17)
R	Percent of students who experience a relapse.	(20)
Y	Number of years of quality-adjusted life expectancy in either the TAU or CRP condition.	(6,38)

the total societal cost was multiplied by the proportion of the total SUD population that college students represent, which is approximately 0.052 (1). Thus, the total cost to society of

SUD among college students in one year is estimated to be $23,019,898,477.16, which represents the TAU condition. The per-person cost of college student SUD (variable C_i was found by dividing the cost of college student SUD by the number of college students with SUD, and was $22,436.55 per student. The formula for estimating the cost of TAU from the societal perspective is shown in figure 2.

Figure 2. The cost of TAU from the societal perspective.

$$C = Total\ Cost\ to\ Society * \frac{Number\ of\ college\ students\ with\ SUD}{Number\ of\ Americans\ with\ SUD}$$

Estimating costs for the societal perspective intervention condition involves several assumptions. First, that a student who is participating in a CRP is not adding to the total societal costs, thus the per-person cost of SUD attributable to that student must be subtracted from the total cost to society. The second assumption is that only direct costs will be of interest to stakeholders, thus opportunity costs that CRP participants might incur will not be included in the model. The only direct cost to consider in this case is the CRP's budget. CRP budgets were estimated from the Jones and Eisenhart data set (19). Twenty CRPs provided sufficient information about staff salaries and the proportion of the overall budget that salaries represented in order to solve for an estimated total budget for the CRP (19). Thus, intervention costs are the total costs to society with the savings attributed to CRP participants subtracted, plus the average estimated budget for a CRP. The estimated number of CRP participants is adjusted to account for the average 8% relapse rate (20). Mean membership size for CRPs were estimated from a survey of 124 CRPs (17). Respondents reported membership size categorically, and true membership sizes were either interval censored ("6 to 10 members") or right censored ("51+ members"), and thus the true mean of membership sizes cannot be known from this dataset. To obtain an estimated mean for use in the base case models, the right-censored category was converted to an interval ("51 to 60 members") and the midpoint of each interval was used to calculate a mean. The converted right-censored category is an overly conservative estimate: the largest CRPs serve as many as 100 students or more (39). While many CRPs also serve a vital function as health educators and resource brokers on their campuses, serving hundreds or thousands of students through education, training, or referrals, this CEA will be limited to accounting for their core function of recovery support. Figure 3 represents the estimated cost of the intervention condition.

Figure 3. Estimated cost of the intervention condition.

$$C - \left(M * (1 - R)\right) + B$$

From the institutional perspective, total costs include the cost of lost tuition revenue due to substance use-related attrition, and the opportunity costs of campus staff handling substance use-related cases. Substance use-related attrition is estimated to account for approximately 10% to 20% of general attrition, and 15% is used for the base model (40). The average general attrition rate is 24.7% (41). The average cost of annual tuition across all institutions is $26,120 (42). With an average undergraduate enrollment size of 4,551, the tuition revenue lost to substance-related attrition is just over $5.8 million at an average institution (43). Figure 4 presents the formula for estimating tuition lost to substance use-related attrition.

Figure 4. Estimation of tuition lost to substance use-related attrition.

$$T * E * General\ Attrition\ Rate * Substance\ Related\ Attrition\ Rate$$

Opportunity costs for the institutional perspective are estimated by first finding the average hourly pay for three types of campus staff frequently responsible for handling substance-related cases: student conduct officers (44), counselors (45), and campus law enforcement officers (46). Drug and alcohol-related incidents occurring on college campuses must be tracked and reported in a biennial review as required by the Drug-Free Schools and Communities Act (47). These incidents include both referrals to student conduct officers for drug and alcohol-related offenses, as well as on-campus arrests involving substances (43). To find the number of referrals and arrests attributable to a particular school, the proportion of the college population that the school represents is found by dividing the number of students at the school by the total number of undergraduate college students enrolled in a given year. This proportion is then multiplied by the number of referrals and arrests to find the approximate number attributable to the school. To find the total opportunity costs for student conduct referrals and arrests, the estimated number of cases is multiplied by the average hourly wage for student conduct officers and campus police officers. This approach likely underestimates opportunity costs, as it assumes only one hour of a staff person's time per case. Figure 5 presents the formula for estimating opportunity costs associated with arrests and student conduct incidents related to substance use.

Table 2. Variables for the CRP CEA institutional perspective model.

Variable	Name	Description	Source
A	Attrition	Tuition lost to substance-related attrition annually.	(40,41)
A_s	Attrition rate (substance-related)	Rate of substance-related attrition.	
A_g	Attrition rate (general)	Rate of general attrition.	
O_s	Opportunity cost – Student Conduct	The opportunity cost of Student Conduct staff working cases attributed to substance use.	(43,44)
O_c	Opportunity cost – counseling services	The opportunity cost of counseling center staff seeing patients for substance use-related sessions.	(48,49)
O_a	Opportunity cost – arrests	The opportunity cost of law enforcement for substance-related arrests on campus.	(43,46)
$S_{s,c,a}$	Per-student opportunity cost	Per-student opportunity cost for each type of opportunity cost described above.	See above
E	Enrollment	Undergraduate enrollment.	(43)
T	Tuition	Cost of tuition for 1 year.	(42)

Figure 5. Estimation of opportunity costs associated with arrests and student conduct incidents involving substance use.

$$O_{s,a} = Staff\ Wage * (Total\ Number\ of\ Incidents * \frac{Enrollment\ Size}{Total\ \#\ College\ Students})$$

The method for calculating the opportunity costs for counselors is different because substance-related counseling appointments are not required to be tracked under the Drug-Free Schools and Communities Act. First, the average percent of the student body served by the counseling center was identified as 12%, though the range of variation is wide (1% to 74%) (48). Next, the prevalence of substance-related problems among students presenting to the counseling center for treatment was found (11%), as well as the average number of sessions per client, which was 5.5 (49). Thus, the number of counseling sessions attributable to substance use disorder is a function of the enrollment size, and this number of sessions is multiplied by the average hourly wage for counselors. This is also likely to be an underestimate, as the costs captured here represent only the time spent in session with the student and does not capture time spent on associated paperwork or case management. Figure 6 presents the estimation of opportunity costs associated with counseling for students with substance-related problems.

Figure 6. Estimation of opportunity costs for students seeking counseling services for substance-related problems.

$$O_c = E * \%\, Students\ Served * \%\, Substance\ Use\ Cases * \#\, Sessions$$

To estimate the cost of TAU, the total opportunity costs are added to the cost of substance-related attrition. To estimate the cost of the intervention condition, the cost attributable to each student who is participating in the CRP and is assumed to not be adding to these lost tuition costs or opportunity costs, is subtracted from the cost of TAU, and adjusted to account for relapse. The cost of the CRP budget is also included in the cost of the intervention condition. Figure 7 represents the estimation of the cost of TAU and the cost of the intervention condition from the institutional perspective.

Estimating Effect

For the societal model, the outcome of interest, or effect for which the cost is being calculated, is the QALY (3,4). Measuring SUD-related quality of life is challenging, and may vary widely depending on the type of drug an individual primarily consumes, their socioeconomic status, co-occurring mental or physical health conditions, and other

Figure 7. Institutional model cost of TAU and cost of intervention condition.

$$TAU = A + O_c + O_s + O_a$$

$$Intervention = B + TAU - \big((M * 1 - R) * T\big) - \sum S_{s,c,a} * M * (1 - R)$$

demographic and life history factors, but more comprehensive measures of recovery capital do not directly translate into life years (6,50–53). Here, disability weights for different kinds of SUD (e.g. alcohol use disorder, opioid use disorder, etc.) from the Global Burden of Disease study were averaged for an aggregate SUD disability weight (6). Disability weights are effectively the inverse of a quality of life adjustment, and may be converted to use for the calculation of QALYs by subtracting the disability weight from 1 (54). The average quality of life adjustment was 0.586 (see table 3), but variable, with a range of 0.741 to 0.359 (6,54). The quality of life adjustment was then entered into Muennig's quality-adjusted life expectancy calculator to find the new life expectancy for the two relevant age cohorts (ages 15 to 19 and 20 to 24), and the difference between the SUD condition life expectancy and the good health condition life expectancy was averaged for the two groups (38). The average QALYs gained were 25.2 years.

The institutional perspective is concerned with students retained who would otherwise have been lost to attrition as a measure of program effect. Part of the formula used to calculate the cost of substance-related attrition was used to calculate student attrition: the

Table 3. Health-related quality of life adjustments for substance use disorder, calculated from Whiteford et al., 2013.

Condition	Disability Weight	CI	QOL Adjustment
AUD - Mild	0.259	(0.176-0.359)	0.741
AUD - Moderate	0.388	(0.262-0.529)	0.612
AUD – Severe	0.549	(0.384-0.708)	0.451
Cannabis Dependence	0.329	(0.223-0.455)	0.671
Cocaine Dependence	0.376	(0.235-0.553)	0.624
Opioid Dependence	0.641	(0.459-0.803)	0.359
Amphetamine Dependence	0.353	(0.215-0.525)	0.647
Composite SUD Score	**0.414**		**0.586**

total undergraduate enrollment size was multiplied by the general attrition rate, and again multiplied by percent of that attrition that is attributable to substance use, or about 15% (40,41). To estimate the number of students who would avoid being lost to substance-related attrition, the number of students who participate in the CRP multiplied by 1 minus the relapse rate are subtracted from the total number of students lost to substance-related attrition. Figure 7 demonstrates how the effect was estimated for the institutional perspective.

Figure 8. Formula for the estimation of intervention effect in the institutional perspective.

$$Intervention\ Effect = \#\ Students\ Lost - (M * (1 - R))$$

Data Analysis

Societal Perspective

Each of the point estimates discussed above form the base case cost-effectiveness analysis. The value for each point estimate is provided in table 4. The incremental cost, or numerator, was found by subtracting the cost of TAU from the cost of the intervention from the societal perspective. The incremental effect was found by subtracting the quality-adjusted life expectancy (QALE) in the TAU condition from the QALE in the intervention condition. To find the incremental cost effectiveness ratio (ICER) or cost per unit of health outcome, the incremental cost was divided by the incremental effect.

Each point estimate forming the base case model has some level of uncertainty. Due to the scarcity of data about CRPs, the CRP modeled from the data is particularly uncertain. To account for this uncertainty, and to understand which variables have the most impact on the model, two types of sensitivity analysis were conducted. First, one-way sensitivity analyses were conducted in Excel by allowing one variable to vary over a plausible range of values while holding all other variables constant. The range of variation for each variable, as well as the source for that variation is detailed in Table 4. After identifying the influence each variable had over the model, critical thresholds of cost-effectiveness and cost savings were noted. The second type of sensitivity analysis conducted was a multi-way sensitivity analysis, in this case a Monte Carlo simulation. Each variable was allowed to vary within the parameters in Table 4, and an ICER was calculated for each of 10,000 iterations of variation. This allowed for the calculation of a new simulated ICER, along with a 95% confidence interval. A triangle distribution was assumed for each variable except CRP membership, which was assumed to be Poisson distributed. The Monte Carlo simulation was conducted in RStudio (55), and the code is included in Appendix B.

The range of variation for each parameter was either determined from the literature or by adding or subtracting 20% from the base case parameter (see table 4). The incremental cost to society (Ci) range of variation is drawn from the literature, with the low estimate at

$15,227 and the base case at $22,436 (27,28). CRP budget variation was estimated by calculating the average budget for the top 50% most costly programs and the average for the bottom 50% (19). Early stage CRPs can be expected to have smaller membership sizes than

Table 4. Parameters for sensitivity analyses of the societal model.

Variable	Base Case	Low	High	Source
C	$23,019,898,477	$18,415,918,781	$27,623,878,172	+/- 20%
C_i	$22,436	$15,227	$22,436	(27,28)
B	$191,389.44	$159,399.47	$223,379.40	(19)
M	14	8	19	(17)
R	8%	0%	25%	(20)
Y*	0.586	0.359	0.741	(6,38)

* Reported as quality of life adjustment used in the calculation of quality-adjusted life expectancy.

programs that are more developed, so a mean for programs identified as early stage and a mean for programs identified as middle to late stage were calculated as the lower and upper bounds of variation, respectively. The reported relapse rate range is 0% - 25% (20). The variation in life years gained is bounded by the lowest quality of life adjustment in Table 3 (“AUD – Mild”) and the highest (“Opioid Dependence”) (6).

Institutional Perspective

Each point estimate used in the base case model was collected as described in the previous section (see table 2), and the value of each point estimate is provided in table 5. The incremental cost, or numerator, was found by subtracting the cost of TAU from the cost of the intervention condition. The incremental effect, or denominator, was found by subtracting the number of students lost to substance-related attrition in the intervention condition from the number of students lost in the TAU condition. Because this is expected to yield a negative value, and the outcome of interest is a positive value (number of students retained who would have otherwise been lost to substance-related attrition), the observed value will be subtracted from the expected value. The value of the TAU condition should then equal zero, as the same number of students who are expected to be lost to attrition would be, and the estimation of the intervention condition will be a positive value. Figure 9 presents the formula used in the denominator to find incremental effect. The ICER was determined by dividing the incremental cost by the incremental effect to find the cost per unit of effect in the base case.

Figure 9. Calculation of the incremental effect, or denominator, for the institutional model.

$$TAU = \left(E * A_s * A_g\right) - \left(E * A_s * A_g\right)$$

$$Intervention = \left(E * A_s * A_g\right) - (\left(E * A_s * A_g\right) - \left(M * (1 - R)\right))$$

The methods for the one-way sensitivity analysis and the Monte Carlo simulation were the same for both the societal and institutional model. The parameters used in the sensitivity analyses for the institutional model are provided in table 5, and the code used for the Monte Carlo simulation in RStudio (55) is provided in Appendix B.

Because the cost of substance-related attrition (variable *A*) is a function of the rate of substance-related attrition (variable A_s) and general attrition (variable A_g), only substance-related attrition was varied in the sensitivity analyses. The range of 10% to 20% was provided as a plausible range in the original source material (40). Opportunity costs were varied by 20% rather than identifying plausible ranges of variation for each component of the formula used to estimate these costs. No confidence interval or variance parameters were found for the hourly wages used in the calculation of opportunity costs, so these were also varied by 20%. The same procedure for establishing a plausible range of variation for the CRP-specific parameters (CRP budget, membership and relapse rate) was used in both the societal and the institutional model. An approximate range of variation from the literature was found for enrollment sizes and tuition costs and rounded to the nearest thousand (42,43,56,57).

Table 5. Parameters for sensitivity analyses of the institutional model.

Variable	Base Case	Low	High	Source
A	$4,404,212.05	$2,936,141.36	$5,872,282.73	(40)
A_s	15%	10%	20%	
O_s	$1,078.41	$862.73	$1,294.10	+/- 20%
O_c	$8,393.03	$6,714.43	$10,071.64	
O_a	$272.85	$218.28	$327.41	
S_s	$19.59	$15.67	$23.51	+/- 20%
S_c	$25.14	$20.11	$30.17	
S_a	$30.27	$24.22	$36.32	
B	$191,389.44	$159,399.47	$223,379.40	(19)
M	14	8	19	(17)
R	8%	0%	25%	(20)
E	4,551	2,000	60,000	(43,56)
T	$26,120	$5,000	$50,000	(42,57)

Toolkit

The Cost-Effectiveness Toolkit for Collegiate Recovery Programs (the Toolkit) was created in Excel using the methods described above for the base case calculations of incremental cost, incremental effect, and ICER. In the societal perspective model, users may enter their own data for an existing or proposed CRP, including CRP budget, membership size, and relapse rate. In the institutional model, users may enter CRP data as well as data specific to their own institution. A worksheet for estimating institution-specific attrition costs (variable A), opportunity costs (variable $O_{s,c,a}$) is included in the Toolkit. Users may also enter tuition costs and enrollment size specific to their institution. Appendix A provides additional details about using the Toolkit for custom estimations of ICER.

Human Subjects

This study is a secondary analysis of existing, de-identified data. No names of individuals or institutions will be included in any report or publication resulting from this study. This study was reviewed by the Committee for the Protection of Human Subjects at the University of Texas Health Science Center at Houston and was declared exempt according to 45 CFR 46.101(b). It was approved on December 6, 2018 (IRB number HSC-SPH-18-1052).

JOURNAL ARTICLE

Collegiate Recovery Programs are a Cost-Effective Tool to Address Substance Use Disorder in Young Adults - *Addiction*

Introduction

Substance use disorder (SUD) affects a substantial portion of the population (7.2%), and is especially prevalent among undergraduate students aged 18 to 22 at 13.5% (1,2). These disorders are estimated to cost the US $442 billion annually, in part due to rising costs associated with treatment episodes (3–6). Further driving the costs to society are the lack of recovery support resources that help to reduce relapse and repeat treatment episodes. Most (63%) people have had more than one treatment episode and 15.5% had five or more treatment episodes (7). Collegiate recovery programs (CRPs) offer a potential amelioration to the tremendous costs to society both in terms of financial costs and lost life years, as students and alumni of these programs tend to experience much lower relapse rates than the general population in SUD recovery (8–10).

While CRPs are promising, little is known about the efficiency of these programs, as no economic evaluation of CRPs has yet entered the literature. This study represents the first such evaluation of CRP efficiency in the form of a comprehensive cost-effectiveness analysis from the societal perspective. This paper has a companion piece examining CRP cost-effectiveness from the perspective of institutions of higher education (11,12). A secondary objective of this research was to create a toolkit for individual advocates and decision-makers to examine the cost-effectiveness of an existing or proposed CRP using user-supplied data.

Methods

Cost-Effectiveness Analysis

Cost-effectiveness analysis involves the estimation of a cost per unit of desired health outcome as a measure of program efficiency (13,14). Costs are estimated for both the treatment as usual (TAU) and intervention (CRP) scenario, as are outcomes or effects. The incremental cost is found by subtracting the cost of TAU from the cost of the CRP scenario (13,14). The denominator of the ratio is the difference between the intervention effect and the TAU effect (13,14). In this case, the effect of interest is quality-adjusted life years added by CRPs compared to TAU. The incremental cost or numerator is divided by the incremental effect or denominator, resulting in an incremental cost-effectiveness ratio (ICER) (13,14).

Estimating Costs

Total costs to society and costs per treatment episode were drawn from the literature (3,4,15). Only the portion of societal costs attributable to college students with SUD were captured in the model (1). Budgets for CRPs were estimated from a 2015 survey of CRP staff wherein 20 respondents provided sufficient information with which to estimate a total budget for the program (16). Membership sizes for CRPs were estimated from an interval-censored and right-censored data set, where mean values were used in place of intervals to calculate an approximate mean (17). Previous outcome evaluation research on CRPs indicate a low relapse rate (8%) and provide a measure of variance (8). Variables used to calculate cost are detailed in table 1, and table 2 provides a pointe estimate for each variable.

Estimating Effect

The outcome of interest is quality-adjusted life years (QALYs) gained by the intervention compared to TAU (13,14). Quality of life adjustments for calculating quality-adjusted life expectancies vary widely depending on substance used and severity of the condition, thus an average figure was used (18). The average quality of life adjustment was calculated by first converting disability weights from Whiteford et al. to quality of life adjustments by subtracting from 1, and scores were averaged across all conditions (18,19). The resulting averaged SUD quality of life adjustment was entered into a life expectancy table to gain an average life expectancy across the two relevant age groups (15 to 19 and 20 to 24) (20). The parameters used in the calculation of effect are detailed in table 1, and the point estimate used in the base case model is provided in table 2.

Dealing with Uncertainty

Two types of sensitivity analysis were undertaken to explore uncertainty in the model. First, one-way sensitivity analyses allowed for the exploration of how each variable impacts the ICER when allowed to vary across a plausible range of variation, while holding all other variables constant. The second type of sensitivity analysis conducted was a Monte Carlo simulation to examine the impact of allowing all variables to vary simultaneously over 10,000 simulated iterations. The resulting averaged ICER and 95% confidence interval provides an estimate that accounts for variation in all of the variables simultaneously. The parameters used for both types of sensitivity analysis are presented in table 2.

Results

The cost of operating a CRP in the base case is $97,586.24 less than the cost of treatment as usual and adds just over 25 QALYs. The incremental cost-effectiveness ratio (ICER) for the societal model in the base case is -$3,872.75, or a cost savings of $3,872.75 per QALY gained when implementing a CRP (see Table 1).

The results of the one-way sensitivity analysis are presented in Figure 1 and Table 2. Throughout the range of variation of each of the parameters, except for CRP membership, the utilization of a CRP was always an overall cost savings. In the case of CRP membership, the intervention is not an overall cost savings at the lowest end of the range of variation (8 members); however, it is still cost-effective in that it is both less expensive than an additional treatment episode, and less expensive than the commonly-used $50,000 benchmark for acceptable cost per QALY (5,6,21). When all other parameters in the base case are held constant, at least 10 CRP members are needed to constitute cost savings. CRP membership held the most influence over the model compared to other variables. One-way sensitivity analyses of effectiveness, in this case QALYs gained, were conducted but not included here. It is an established phenomenon that when numerators are negative, one-way sensitivity analyses of effectiveness do not produce expected results, in this case, as effectiveness increased the intervention appeared to become more expensive (22–24).

The Monte Carlo simulation resulted in a slightly lower predicted cost savings of -$2,990.94 (95% CI; -$3,073.11, -$2,908.77) over 10,000 iterations.

Discussion

Because the ICER is negative, caused by a negative numerator in the initial CEA calculation, there is some ambiguity to the interpretation of these results. When the cost of the new intervention being compared to treatment as usual represents an overall cost savings, the numerator will be negative, leading to a negative ICER. A negative ICER has been interpreted to mean that the intervention is an overall cost savings per unit of health outcome, but others argue that the interpretation is less straightforward (22–24). Further, measures of effectiveness in the denominator, in this case QALYs gained, cannot be subjected to a sensitivity analyses, as the results will be the inverse of what is expected (4-6).

The more conservative estimate of ICER in the Monte Carlo simulation may be due to the use of triangle distribution for all simulated variables except CRP membership, which was assumed to be Poisson distributed. The triangle distribution may provide an overly cautious representation of the true range of variation among CRPs but must be used as the true distribution is unknown due to the limited number of studies that capture data about CRP operations.

The primary limitation of this study is the limited availability of data about collegiate recovery programs. Due to the rapid growth in the field in recent years, data collection efforts have lagged behind need. The data set from which CRP budget information was gathered represents only 54 of the 184 currently operating CRPs, and only 20 of these respondents provided budgetary information (16,21). Relapse rates for CRPs are even more dated, collected in 2012 when only 29 CRPs were in operation (14). While these factors pose a limitation to the model CRP created for use in CEA here, this limitation does not apply to collegiate recovery professionals and advocates who wish to substitute their own CRP's data for the model CRP data used here. Interested advocates may do so by using the Cost-Effectiveness Toolkit for CRPs ("the Toolkit") at <<URL forthcoming>>.

As healthcare costs continue to rise during a time when unprecedented numbers of Americans are struggling with opioids, it is essential to find cost-effective solutions to help prevent relapse among those who receive treatment. The wide range of variation in which CRPs represent a cost savings compared to treatment as usual is promising to the continued proliferation of these programs at colleges and universities across the country. A companion article presents the institutional perspective cost-effectiveness analysis of CRPs, and both perspectives demonstrate cost-effectiveness and cost savings (11).

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Figures and Tables

Table J1.1. Variables used in the societal perspective model.

Variable	Description	Source
C	The portion of the total financial cost to society of SUD attributable to full-time undergraduate college students aged 18-22.	(1,3,4,15)
C_i	Cost of SUD per individual in the target population.	(1,3,4,15)
B	CRP budget	(16)
M	Mean CRP membership	(17)
R	Percent of students who experience a relapse.	(8)
Y	Number of years of quality-adjusted life expectancy in either the TAU or CRP condition.	(18,20)

Table J1.2. Parameters for sensitivity analyses of the societal model.

Variable	Base Case	Low	High	Source
C	$23,019,898,477	$18,415,918,781	$27,623,878,172	+/- 20%
C_i	$22,436	$15,227	$22,436	(5,6)
B	$191,389.44	$159,399.47	$223,379.40	(16)
M	14	8	19	(17)
R	8%	0%	25%	(8)
Y*	0.586	0.359	0.741	(18,20)

* Reported as quality of life adjustment used in the calculation of quality-adjusted life expectancy.

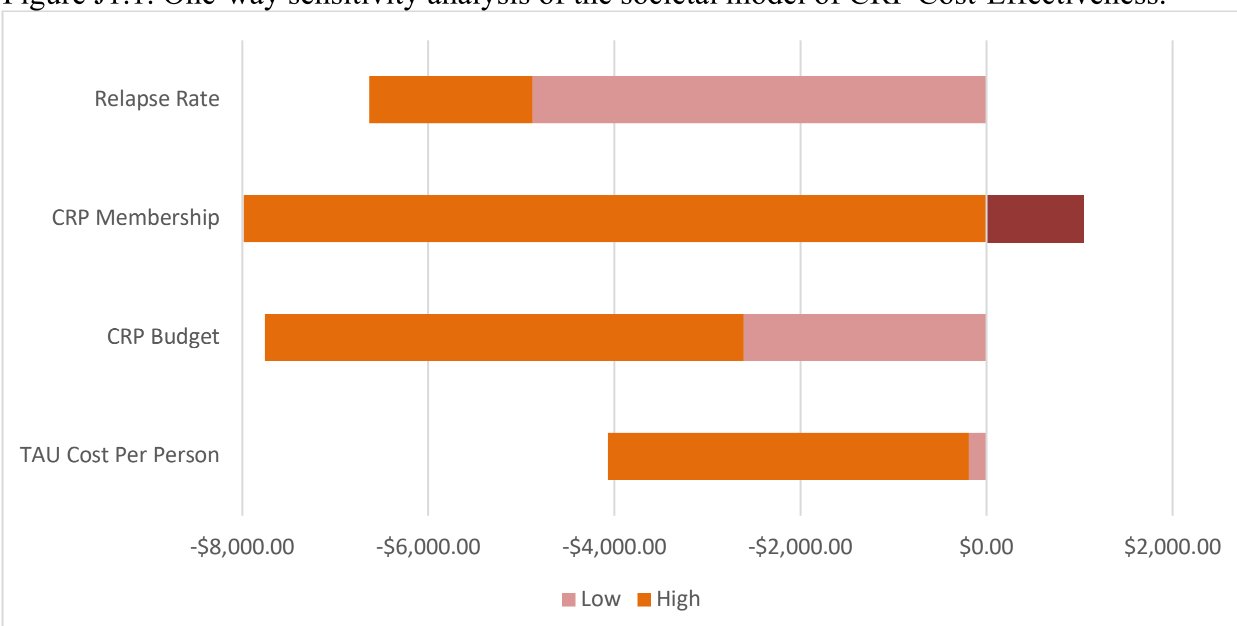
Table J1.3. Cost-effectiveness table for the CEA of CRPs.

Intervention	Total Cost	Total Effectiveness	Incremental Cost	Incremental Effectiveness	ICER
Treatment as Usual	$23.02 billion	35.66 QALE			
Collegiate Recovery Program	$22.991 billion	60.82 QALE	-$97,593.31	25.2 QALE	-$3872.75

Table J1.4. Results of the one-way sensitivity analysis of the societal model cost-effectiveness analysis of CRPs.

Variable	Low	High	Additional Details
TAU Cost Per Person	-$188.22	-$3,879.77	For every $500 increase in the incremental cost of TAU, CRPs represent an additional $256 in cost savings per QALY gained.
CRP Budget	-$2,608.22	-$5,151.89	For every $1,000 additional in CRP budget, only $39 less in cost savings per QALY gained.
CRP Membership	$1,043.89	-$7,983.33	For every CRP member gained, $820 increase in cost savings.
Relapse Rate	-$4,879.11	-$1,757.05	For every 1% increase in relapse rate, $124 reduction in cost savings.

Figure J1.1. One-way sensitivity analysis of the societal model of CRP Cost-Effectiveness.



JOURNAL ARTICLE

Cost-Effectiveness of Collegiate Recovery Programs from the Perspective of Colleges and Universities - *Journal of American College Health*

Abstract

Objective: This cost-effectiveness analysis of collegiate recovery programs (CRPs) from the perspective of institutions of higher education was conducted to fill a critical gap in the evaluation research on CRPs. A companion article on the cost-effectiveness of CRPs from the societal perspective is forthcoming.[1] **Participants:** Two existing data sets were used to construct a model CRP for analysis.[2,3] These data represent 54 and 184 CRPs from across the US.[2,3] **Methods:** A base model incremental cost-effectiveness ratio (ICER) was calculated to assess cost per student retained from substance-related attrition. One-way and multi-way (Monte Carlo simulation) sensitivity analyses explored uncertainty in the base model and identified critical thresholds. **Results:** CRPs represent an overall cost savings, with an ICER of -$11,230.93 per student retained. CRPs remain a cost-saving intervention across a wide range of plausible variation, including in the Monte Carlo simulation (ICER = -$8,196.28; 95% CI -$8467.48, -$7925.08). **Conclusions:** In spite of the limitations imposed by data availability and uncertainty, CRPs are cost-effective and cost-saving across a wide range of variation.

Keywords: Substance use disorder, recovery, collegiate recovery programs, cost-effectiveness, efficiency evaluation.

Introduction

Collegiate recovery programs (CRPs) have a long history, with the first programs established in the 1970s and 1980s, but these programs did not proliferate widely until recent years.[3] This recent growth in the field – from approximately 29 programs in 2012 to just over 184 programs today – is in part due to increased attention paid to substance use disorders (SUD) among young adults in light of the national public health crisis related to opioids.[3–5] These programs can play a critical role in ensuring that costly interventions for SUD are less likely to result in a recurrence of use, given that participants in these programs are less likely to relapse than the general SUD population, and that this recovery protection carries on past graduation.[5–7]

In spite of these promising outcomes, CRPs have not been as widely adopted or supported as may be expected. For example, a minority (39%) of currently operating CRPs report full institutionalization in the form of funding and inclusion in strategic planning within the larger university setting.[3] One possible explanation for the slow diffusion of CPRs into the college health landscape are concerns regarding expense and efficiency. To date, no evaluation of the efficiency of a CRP has been published in the literature, representing a critical gap in the evaluation research on these programs.

This study represents the first evaluation of CRP efficiency in the literature, using the method of cost-effectiveness analysis (CEA). This CEA of a CRP modeled from existing data sources is from the perspective of institutions of higher education, and thus reports findings in terms of students who have been retained instead of lost to substance use-related attrition. Substance use-related attrition is believed to represent between 10% and 20% of all attrition cases among first-year students, though the model presented here accounts for uncertainty in this estimate.[8] A companion article assessing cost-effectiveness of CRPs from the perspective of society, which measures the cost of a CRP per additional quality-adjusted life year (QALY) gained, is forthcoming.[1] Those who wish to assess cost-effectiveness at their own CRP may do use by using the Cost-Effectiveness Toolkit for CRPs at <<URL forthcoming>>.

Methods

Cost-effectiveness analysis is the method of assessing how much an intervention costs compared to the standard method of care, in terms of cost per unit of health outcome.[9,10] In this case, operating a CRP on a college campus is compared to not offering a CRP, but offering standard services such as counseling and student conduct case management. The cost of these services are captured as opportunity costs in the model. These costs are then divided by the desired health outcome achieved by the intervention, in this case students retained who would otherwise have been lost to substance-related attrition.

The first layer of analysis is the single point estimate of the incremental cost-effectiveness ratio (ICER), or the cost per student retained. The cost to institutions of not having a CRP was estimated by first calculating tuition dollars lost to substance-related attrition, and combining that with opportunity costs of campus staff who may interact with students in active SUD.[8,11–16] The average number of undergraduate students per college campus and the median annual tuition across the US were used in the base model.[11,17] Average CRP budgets and participation sizes (also called membership) were calculated from two national surveys of these programs, and found to be approximately 14 students, though there is wide variation between programs.[2,3] Average relapse rates among CRP students (8%), as well as the range of variation in relapse rates (0% - 25%), were from the literature.[5] Table 1 details each of the variables in the institutional perspective model and provides a source for each. Table 2 details the point estimate for each variable.

To account for uncertainty in model estimations, as well as to account for variation in program size, membership, relapse rates and other variables, two types of sensitivity analysis were conducted. First, one-way sensitivity analyses demonstrated the impact of each variable on the overall model and the resulting ICER, and allowed for the identification of critical thresholds of cost per unit of health outcome. Multi-way sensitivity analysis, in this case a Monte Carlo simulation, allows all variables to vary simultaneously within a given set of parameters. The 10,000-iteration Monte Carlo simulation was conducted in RStudio, and provided an estimation of the variance of the overall model.[18,19] Triangle distributions are assumed for all variables in the Monte Carlo simulation, except CRP membership, which is assumed to be Poisson distributed. The parameters for each variable used in the sensitivity analyses are available in table 2.

Results

In the base model of cost-effectiveness of a CRP from the perspective of the institution, the presence of a CRP saves the university $11,230.93 for each student retained who would otherwise have been lost to substance-related attrition (ICER = -$11,230.94). CRPs can be considered both cost-effective and an overall cost-savings. Table 3 presents the incremental cost, incremental effectiveness, and incremental cost-effectiveness ratio (ICER) of the base model.

The results of the one-way sensitivity analyses are presented in Table 4 and visually represented in Figure 1. The underlying rate of attrition from a university, the rate of attrition attributable to substance use, and the number of undergraduate students enrolled in the institution have no impact on the overall model: the program is equally cost-effective no matter how these components vary. The per-student opportunity costs associated with college or university staff whose caseloads include students who struggle with substances had little impact on the model: for every 20% increase or decrease in per-student opportunity cost, there was a corresponding $15 change in ICER.

Variables that exerted greater influence on the model were the cost of tuition, CRP membership, the CRP budget, and the relapse rate for students participating in the CRP. For every $1,000 that the cost of annual tuition increases, the cost savings to the institution increase by $990.77. The relationship between CRP budget and ICER was also linear: for every additional $1,000 spent on a CRP budget, there was a $77.64 reduction in cost savings when all other variables were held constant. With all other variables constant including a membership of 14 students, a budget of $290,000 and above is no longer a cost savings, though may still be considered cost-effective depending on cost-per-student tolerance at an institution. The relationships of both CRP membership and relapse rate to ICER were non-linear. Throughout the entire range of potential values of relapse rate (0% to 25%), the ICER remained negative representing an overall cost-savings.[5]

The mean ICER from the Monte Carlo simulation of 10,000 variations was -$8,196.28 (95% CI -$8,467.48, -$7,925.08), representing less cost savings per student retained than the point estimate ICER from the base model. The uncertainty introduced by the sparse data available for CRP parameters may contribute to the discrepancy between the Monte Carlo simulation and the base case point estimation.

Comment

Throughout the plausible range of variation for almost all variables, CRPs represent a substantial cost savings to the institution per student. As CRP participation drops, the program becomes less cost-effective, though this effect can be mediated if the budget is appropriately matched to the size of the program in terms of student participants, for example, by maintaining appropriate staff to student ratios. Similarly, campuses with below average tuition costs may experience reduced cost savings, as much of the savings come in the form of avoiding lost tuition due to substance-related attrition. Because relapse rates also exert influence over the model, care should be taken to balance appropriate staff to student ratios with adequate resources to provide support and keep relapse rates low.

CRPs are equally cost-saving across institutions of differing sizes and with differing rates of general or substance-related attrition. While variations in staff salaries may impact the per-student opportunity cost, this type of cost has little impact on the model. For institutions considering adding a CRP to their campus or deepening support for an existing CRP, it is critical to consider thresholds of participation and appropriately matched budgets, though the range of acceptable variation while still maintaining cost savings is wide.

Limitations and Conclusion

A negative value for incremental cost and ICER, representing an overall cost savings, leads to some ambiguities in interpretation.[20–22] The national benchmarking data available for CRPs is limited, and thus a major limitation to this evaluation is the uncertainty inherent in the modeled CRP. In order to minimize uncertainty in the decision-making process, those who wish to explore the cost-effectiveness of a CRP at one's own institution may use the Cost-Effectiveness Toolkit for CRPs available at <<URL forthcoming>> and substitute their own known data. The limitation of the sensitivity analyses is related to data availability, as well: the true range of variation and underlying probability distribution of that variation is not known, and thus the modeled variation presented here is likely to be overly conservative. In spite of these limitations, evidence for the efficiency of CRPs has now been added to the literature, complementing the evidence for the effectiveness of these programs.

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Tables and Figures

Table J2.1. Institutional model parameters and sources.

Variable	Name	Description	Source
A	Attrition	Tuition lost to substance-related attrition annually.	8,23
A_s	Attrition rate (substance-related)	Rate of substance-related attrition.	
A_g	Attrition rate (general)	Rate of general attrition.	
O_s	Opportunity cost – Student Conduct	The opportunity cost of Student Conduct staff working cases attributed to substance use.	11,14
O_c	Opportunity cost – counseling services	The opportunity cost of counseling center staff seeing patients for substance use-related sessions.	12,16
O_a	Opportunity cost – arrests	The opportunity cost of law enforcement for substance-related arrests on campus.	11,13
$S_{s,c,a}$	Per-student opportunity cost	Per-student opportunity cost for each type of opportunity cost described above.	See above
E	Enrollment	Undergraduate enrollment.	11
T	Tuition	Cost of tuition for 1 year.	24

Table J2.2. Parameters for the base case and sensitivity analyses of the institutional model.

Variable	Base Case	Low	High	Source
A	$4,404,212.05	$2,936,141.36	$5,872,282.73	[8]
A_s	15%	10%	20%	
O_s	$1,078.41	$862.73	$1,294.10	+/- 20%
O_c	$8,393.03	$6,714.43	$10,071.64	
O_a	$272.85	$218.28	$327.41	
S_s	$19.59	$15.67	$23.51	+/- 20%
S_c	$25.14	$20.11	$30.17	
S_a	$30.27	$24.22	$36.32	
B	$191,389.44	$159,399.47	$223,379.40	[2]
M	14	8	19	[3] Monte Carlo
	14	1	100	[3,25] One-Way
R	8%	0%	25%	[5]
E	4,551	2,000	60,000	[11,26]
T	$26,120	$5,000	$50,000	[24,27]

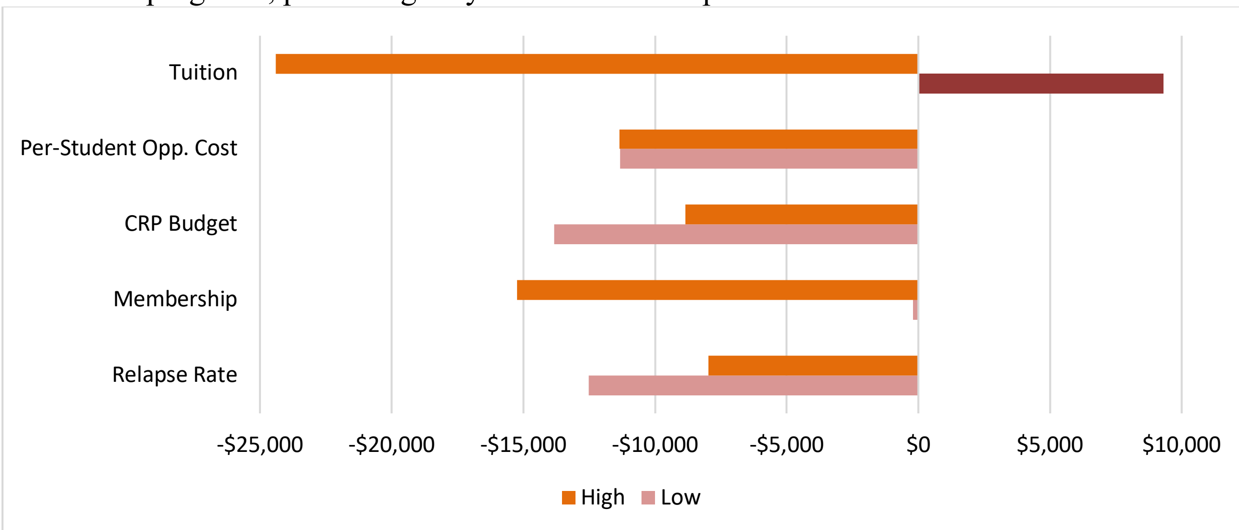
Table J2.3. Cost effectiveness table for collegiate recovery programs from the perspective of institutions of higher education.

Intervention	Total Cost	Total Effect	Incremental Cost	Incremental Effectiveness	ICER
Absence of a CRP	$4,413,656.92	0	N/A	N/A	N/A
Presence of a Collegiate Recovery Program	$4,267,654.79	13	-$146,002.13	13 students retained	-$11,230.93

Table J2.4. One-way sensitivity analysis of the cost-effectiveness of collegiate recovery programs: a description of the impact of each variable on the model.

Variable	Low	High	Additional Details
Tuition	$9,297.81	-$24,388.35	As tuition increases, CRPs become a more cost saving alternative. For every $1,000 increase in tuition, $990.77 increase in cost savings. When annual tuition and fees fall at or below $14,000, the intervention is not a cost savings when other variables are held constant.
Per-Student Opportunity Cost	-$11,320.57	-$11,350.57	For every 20% increase in the per-student opportunity cost, the cost savings increase by $15, and the inverse is also true.
CRP Budget	-$13,819.26	-$8,851.88	For every additional $1,000 spent on a CRP budget, there is a $77.64 decrease in cost savings per student retained.
CRP Membership	-$191.00	-$15,245.95	Non-linear relationship between membership and ICER. The critical threshold below which the intervention is no longer a cost savings is 10 members, but still cost-effective above 2 members.
Relapse Rate	-$12,524.32	-$7,967.43	Non-linear relationship between relapse rate and ICER. The critical threshold below which the intervention is no longer a cost savings is a relapse rate of 40%. The intervention remains cost-effective at or above a relapse rate of 81%.

Figure J2.1. One-way sensitivity analysis of the cost-effectiveness of collegiate recovery programs, presenting only variables that impact the model.



CONCLUSION

From both the societal and institutional perspectives, CRPs are not only cost-effective, but also cost-saving, even over a wide range of variation to account for relatively high amounts of uncertainty in the data. CRP membership size, CRP budget, and relapse rate impact the cost-savings and cost-effectiveness of CRPs compared to TAU in both the societal and institutional perspective models, thus it is important to ensure that CRP hiring practices and budget allocations are an appropriate fit for the membership size. Similarly, it is important to maintain adequate staff to student ratios and provide sufficient resources to CRP operations in order to keep relapse rates contained.

The cost of TAU and tuition also impact the cost-effectiveness and cost savings provided by the intervention. When the cost of additional treatment episodes in the societal perspective model, or the cost of tuition in the institutional perspective model, becomes less expensive, then CRPs represent less of a cost savings and are less cost-effective; however, with both healthcare costs and tuition costs continuing to rise, it is unlikely that these costs will become so inexpensive as to become dominant relative to CRPs.

Given the uncertainty in the data gathered, particularly in the data used to model a typical CRP, the Toolkit provides a tool for advocates seeking to reduce uncertainty by inputting their own data into the models. The primary limitation of this research was the availability of data on CRPs. Only 20 CRPs provided sufficient information from which to estimate a total budget, and CRP membership size was estimated from interval-censored and right-censored data (17,19). One strength of this research is that this uncertainty was explored in depth in two types of sensitivity analyses, and that the cost-effectiveness and cost-savings found in the base model were retained throughout a wide range of variation. The greatest strength of this research is that it represents the first evaluation of CRP efficiency to enter the literature and may spur additional research into the economics of these programs.

APPENDICES

Appendix A: The Cost-Effectiveness Toolkit for Collegiate Recovery Programs.

The Cost-Effectiveness Toolkit for Collegiate Recovery Programs ("the Toolkit") is available at <<URL forthcoming>> and is intended to allow advocates to calculate a specific ICER for their own institution as it currently operates, or to project an ICER for a proposed CRP not yet in operation. The Toolkit contains four tabs: User-Supplied Data, Base Model, Worksheet, and References. The User-Supplied Data tab is where advocates can enter their own real or proposed CRP parameters for either the societal perspective or institutional perspective model, or for both. The Base Model tab provides point estimates for the base case, an estimate of the parameter for a small CRP or a large CRP if applicable, and the range of variation for that parameter used in the Monte Carlo simulation. The Worksheet tab provides a worksheet for users to estimate the cost of tuition lost to substance-related attrition, adapted from the Everfi (n.d.) attrition calculator, as well as a worksheet to estimate opportunity costs related to substance use on campus. The references tab provides full bibliographic references for each of the point estimates and the estimates of the range of variation, where applicable.

The User-Supplied Data tab contains two workspaces: Model 1 – Societal Perspective (see Figure A1) and Model 2 – Institutional Perspective (Figure A2). Only cells highlighted in either yellow or blue may be modified by the user. In both the societal and institutional perspective model, the individual institution's actual or proposed CRP budget, membership size, and relapse rate may be entered. Greater customization is available in Toolkit for the institutional perspective model: the substance-related attrition cost, opportunity cost, tuition, enrollment size, and substance-related and general attrition costs can be customized in addition to the variables mentioned above. The ICER generated from the institution model calculation can then be considered highly customized to that specific institution's parameters.

Figure A1. Societal Perspective customizable model in The Cost-Effectiveness Toolkit for Collegiate Recovery Programs.

Model 1 - Societal Perspective	USER SUPPLIED DATA				
Variable Name	**Description**	**Single Point Parameter**	**Source of Base Model Estimate**	**RESULT TYPE**	**RESULTS**
Total Cost to Society	The portion of the total cost (Surgeon General's Report) to society of SUD in Target Population (college students; SAMHSA, 2017)	$ 23,019,898,477.16	(Sacks et al, 2015; NDIC, 2011; HHS, 2016; CBHSQ, 2018)	Total cost to society	$ 23,019,898,477.16
Incremental Cost to Society	Cost to society per college student with SUD, or C/(number of students w SUD)	$ 22,436.55	(above references & CBHSQ, 2018)	Total cost with CRP	$ 23,019,800,883.85
CRP Budget	Enter your CRP's Budget	$ 191,389.44	(Jones and Eisenhart, 2016)	Incremental cost	-$97,593.31
CRP Membership	Enter the number of students that regularly participate in your CRP or are listed as CRP members.	14	(Transforming Youth Recovery, 2018)	Incremental effect	25.2
Relapse Rate	**Note: use 1 - Relapse Rate. May use your own institution's rates or national average.	92%	(Laudet et al, 2015)	**Incremental Cost Effectiveness Ratio (ICER) - Cost per quality-adjusted life year gained.**	**-$3,872.75**
QALY Adjustment	The quality of life adjustment used to calcualte quality-adjusted life years.	0.586428571	(Whiteford et al., 2013)		
Years Life Expectancy Gained	Number of years an average individual is expected to live with SUD given continued active SUD versus maintained SUD recovery.	25.2	(Muennig, 2008)		

Figure A2. Institutional Perspective customizable model in The Cost-Effectiveness Toolkit for Collegiate Recovery Programs.

Model 2 - Institutional Perspective		USER-SUPPLIED DATA		USE WORKSHEET TAB	
Variable Name	**Description**	**Base Case**		**RESULT TYPE**	**RESULTS**
Attrition	Use the Worksheet tab, Attrition Worksheet section. Enter the value in the "TUITION LOST DUE TO ATTRITION, 1 YEAR" field here.	$	4,383,978.30	Cost of Doing Nothing	$ 4,425,078.68
Total Opportunity Cost	Use the Worksheet tab, Opportunity Cost Worksheet section. Enter the value in the "TOTAL OPPORTUNITY COSTS" field here.		$41,100.38	Intervention Context Cost	$ 4,279,749.73
Per-Student Opportunity Cost	Use the Worksheet tab, Opportunity Cost Worksheet section. Enter the value in the "PER-STUDENT OPPORTUNITY COST" field here.	$	22.73	Incremental Cost	-$145,328.95
Tuition	Cost of tuition for 1 year. Use in-state tuition only for the most conservative estimate. May also calculate average cost based on proportion of in-state, out-of-state, and international tuition payers.	$	26,120.00	Effect of Doing Nothing	0
Enrollment	Enter the number of undergraduate students enrolled at your university.		4,551	Intervention Context Effect	13
CRP Budget	Enter your CRP's Budget	$	191,389.44	Incremental Effect (Number of students retained instead of lost to attrition)	13
CRP Membership	Enter the number of students that regularly participate in your CRP or are listed as CRP members.		14	**Incremental Cost-Effectiveness Ratio (ICER) - Cost per student retained rather than lost to substance-related attrition**	**-$11,179.15**
Relapse Rate	Note: use 1 - Relapse Rate. May use your own institution's rates or national average (8%).		92%		
Retention Rate	Enter the same number used for overall retention rate in the Worksheet tab, Attrition Worksheet section.		0.75		
Substance-Related Attrition	Enter the same number used for substance-related attrition in the Worksheet tab, Attrition Worksheet section.		0.15		

Appendix B. R code used for the Monte Carlo simulation.

Monte Carlo for CEA of CRPs

```
library("triangle",
        lib.loc="/Library/Frameworks/R.framework/Versions/3.5/Resources/li
brary")
library(sn)

set.seed(123)
```

Societal Perspective

```
mc_societal_basecase<-data.frame(
  cost_tau = c(rtriangle(n=10000,a=18415918781.73,b=27623878172.59,c=23019
898477.16)),
  cost_pp = c(rtriangle(n=10000,a=17949.24,b=26923.86,c=22436.55)),
  budget = c(rtriangle(10000,a=159399.47,b=223379.40 , c=191389.44)),
  memb = c(rpois(10000,8:19)),
  relapse = c(rtriangle(n=10000,a=0.75,b=1,c=0.92)),
  qalys_added = c(rtriangle(n=10000,a=15.75185654,b=38.98432449,c=25.2))
)

mcsoc<-mc_societal_basecase
mcsoc$icost<-(mcsoc$cost_tau-((mcsoc$memb*mcsoc$relapse)*mcsoc$cost_pp)+mc
soc$budget)-mcsoc$cost_tau
mcsoc$ieffect<-mcsoc$qalys_added
mcsoc$icer<-mcsoc$icost/mcsoc$ieffect

mcm<-mean(mcsoc$icer)
print(mcm)
#mean= -2990.941
mcsd<-sd(mcsoc$icer)
print(mcsd)
#sd = 4192.469
mcz<-1.96
mcme<-(mcz*mcsd)/sqrt(10000)
mccih<-mcm+mcme
mccil<-mcm-mcme
print(mccil)
# -3073.113
print(mccih)
# -2908.769
```

Institutional Perspective

```
nat_stu_conduct_subs <-(56038+184681)
nat_arr_subs <-(19423+19992)
```

```
oppcost_pp_cond <- c(rtriangle(n=10000,a=15.67,b=23.51,c=19.59))
oppcost_pp_couns <- c(rtriangle(n=10000,a=20.11,b=30.17,c=25.14))
oppcost_pp_arr <- c(rtriangle(n=10000,a=24.22,b=36.32,c=30.27))
budget <- c(rtriangle(10000,a=159399.47,b=223379.40 , c=191389.44))
memb <- c(rpois(10000,8:19))
relapse <- c(rtriangle(n=10000,a=0.75,b=1,c=0.92))
enrollment <- c(rtriangle(n=10000,a=2000,b=60000,c=31000))
tuition <- c(rtriangle(n=10000,a=5000,b=50000,c=26120))
gen_attrition <- c(rtriangle(n=10000,a=0.18525,b=0.30875,c=0.247))
subs_attrition <- c(rtriangle(n=10000,a=0.1,b=0.2,c=0.15))

mci_bc1<-data.frame(
  attrition = c(tuition*(enrollment*gen_attrition*subs_attrition)),
  attributable_to_school = c(enrollment/19900000)
  )

mci_bc<-data.frame(
  tot_oppcost_cond = c(nat_stu_conduct_subs*mci_bc1$attributable_to_school
*oppcost_pp_cond),
  tot_oppcost_couns = c((((enrollment*0.1206)*5.53)*0.11)*oppcost_pp_couns
),
  tot_oppcost_arr = c(nat_arr_subs*mci_bc1$attributable_to_school*oppcost_
pp_arr)
)

inst_mc<-data.frame(
  tot_oppcost_cond = c(mci_bc$tot_oppcost_cond),
  tot_oppcost_couns = c(mci_bc$tot_oppcost_couns),
  tot_oppcost_arr = c(mci_bc$tot_oppcost_arr),
  attrition = c(mci_bc1$attrition),
  attrib = c(mci_bc1$attributable_to_school),
  oppcost_pp_cond =c(oppcost_pp_cond),
  oppcost_pp_couns = c(oppcost_pp_couns),
  oppcost_pp_arr =c(oppcost_pp_arr),
  budget =c(budget),
  memb=c(memb),
  relapse=c(relapse),
  enrollment=c(enrollment),
  tuition=c(tuition),
  gen_attrition=c(gen_attrition),
  subs_attrition=c(subs_attrition)
)

inst_mc$DoNothingCost<-(inst_mc$attrition+
                                inst_mc$tot_oppcost_arr+
                                inst_mc$tot_oppcost_couns+
```

```
                                inst_mc$tot_oppcost_cond)
inst_mc$CRPCost<-(inst_mc$DoNothingCost-
                          (inst_mc$tuition*
                             inst_mc$memb*inst_mc$relapse)-
                          ((inst_mc$memb*inst_mc$relapse)*
                             (inst_mc$oppcost_pp_cond+
                                inst_mc$oppcost_pp_arr+
                                inst_mc$oppcost_pp_couns))+
                          inst_mc$budget)

inst_mc$icost<-inst_mc$CRPCost-inst_mc$DoNothingCost

inst_mc$DoNothingEffect<-(inst_mc$enrollment*inst_mc$gen_attrition*inst_mc
$subs_attrition)-
  (inst_mc$enrollment*inst_mc$gen_attrition*inst_mc$subs_attrition)

inst_mc$CRPEffect<-round((
  inst_mc$enrollment*inst_mc$gen_attrition*inst_mc$subs_attrition)-
  ((inst_mc$enrollment*inst_mc$gen_attrition*inst_mc$subs_attrition)-
  (inst_mc$memb*inst_mc$relapse)),0)

inst_mc$ieffect<-(inst_mc$CRPEffect-inst_mc$DoNothingEffect)

inst_mc$ICER<-(inst_mc$icost/inst_mc$ieffect)

mcm_inst<-mean(inst_mc$ICER)
print(mcm_inst)
#mean= -8196.281
mcsd_inst<-sd(inst_mc$ICER)
print(mcsd_inst)
#sd = 13836.75
mcz<-1.96
mcme_inst<-(mcz*mcsd_inst)/sqrt(10000)
mccih_inst<-mcm_inst+mcme_inst
mccil_inst<-mcm_inst-mcme_inst
print(mccil_inst)
# -8467.481
print(mccih_inst)
# -7925.081
```

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