Research Article

Modelling the Clinical and Economic Impacts of Foundation-Funded versus Staff-Driven Quality Improvement Mental Health Strategies

Eden McCaffrey[1], David Cawthorpe[2]

1. Child and Adolescent Addiction and Mental Health and Psychiatry Program, Alberta Health Services, Calgary, Canada; 2. Department of Psychiatry, Cumming School of Medicine, University of Calgary, Canada

Background

Employing a valid and reliable clinical measurement system established in 2002 within our regional Child and Adolescent, Addictions, Mental Health, and Psychiatry Program, we have been able to measure the effect of the general service system, a novel pre-admission initial family group session to orient families to treatment, and an acute at-home care service designed to divert admissions from emergency to in-home support rather than inpatient admission. Additionally, we modelled the clinical effect and economic impact of two community programs: one school-based mental health literacy program and one primary care physician training and education program focusing on the management of children's mental health problems. In this paper, we present an established clinical measurement system combined with a standardized cost evaluation strategy to assess the respective cost/benefit impacts of four service innovations.

Methods

The clinical measurement system has been described in detail, as has its role in measuring the impact of community-level training on the quality of referrals. Our financial department developed standardized per diem cost references for levels of care within our system. The cost references permitted comparison of groups that were exposed and unexposed to the system innovations before and after the initiation of service and community innovations. The school-based mental health literacy program was a regional implementation of a national program (https://mentalhealthliteracy.org/). The primary care physician education was an internationally developed program from the United States (https://thereachinstitute.org). The other two projects were

accomplished on a somewhat smaller local scale and at lower overall cost. The pre-admission initial family group session was a bottom-up, staff-designed and developed quality improvement project. The acute at-home project, while funded by the children's hospital foundation as were the two national and international projects, was a top-down director-designed project with one manager and a coordinator.

Results

The four innovations were evaluated employing the same model. In each case, the clinical space created by each innovation was measured in terms of the cost saved by comparing the same outcomes (re-admission rates and lengths of stay) over comparable time intervals between and within pre/post exposed and unexposed groups, whilst controlling for clinical effects of exposure and time. The clinical measurement system helped determine group effects to ensure that the target groups were comparable within each initiative's exposed and unexposed groups and were appropriately distinct between initiatives (e.g., appropriate clinical groups were served by each initiative). While the four projects were different and served somewhat different patient groups, the pre-admission initial family group session was the most cost-effective. The physician training program was both effective and cost-neutral. The school-based mental health literacy program was the least evaluable due to the direction of implementation and tended to increase referrals rather than create clinical space for more affected youth, as might be expected. The acute at-home project successfully diverted less suicidal patients away from inpatient readmission over the evaluation period.

Discussion

The main implications for mental health policy derive from linking standardized cost and clinical measurement models, permitting economic evaluation of system and community-level innovations. Pre- and post-clinical and cost measurements within and between exposed and unexposed groups for each innovation or project permitted estimation of benefits and costs.

Conclusions

The projects varied in focus together with the evaluability of each project, yet this provided important information for health system innovation and renewal within the context of fiscal constraint. The ranking of the projects in terms of their overall benefits and costs may guide decision-making where maximum return on investment makes the most sense.

Correspondence: papers@team.qeios.com — Qeios will forward to the authors

Background

While mental health economics is central to any consideration of health care optimization, reform, or innovation, there has been a dearth of research on the subject. For example, a title search of PubMed for the terms ‘mental health’ and ‘economics’ conducted on February 3rd, 2022, produced only 54 abstracts, with 12 being from the Journal of Mental Health Policy and Economics. Furthermore, there was only one paper published in 1993 focused on children’s mental health and economics in the title [1] and a total of three that mentioned children or adolescents in the abstract [1][2][3]. Hence, there is an ongoing need to bring economic analysis to the foreground of health care and mental health care research, as economics forms the boundaries of the possible in health care optimization, reform, and innovation.

Models of mental health care assessment have been described [4], are increasing, and are noted to require the measurement and combination of costs and clinical outcomes. Several researchers [2][5][6][7] continue to plead for the integration of behavioral economics and implementation science in order to hasten through valuation the reach and impact of psychiatric treatments.

Aims of the Study

In the present study, we report on one standardized approach employed to evaluate the economic and clinical impact on mental health services of four innovation projects within the publicly funded regional Child and Adolescent Addictions and Mental Health and Psychiatry Program located in Calgary, Alberta. Descriptions of the four innovations have been published [8][9][10][11] and two are presently under review. A brief description of each is provided below:

1. Canadian Research and Education for the Advancement of Child Health (CanREACH) was launched early in 2014 and delivered a mental health literacy training program targeting primary care physicians. The main goal of CanREACH was to deliver a local 5-year mental health literacy (MHL) training program to build case identification, management skills, and confidence in primary care physicians. The CanREACH continuing medical education (CME) initiative received one provincial and one national award in 2019 and has expanded throughout Alberta and to several other Canadian provinces.[9][12]
2. The Acute at Home (AAH) program is an AHS program that was fully operational by June 2019 after a period of development (staff hiring, training, etc.). Upon crisis presentation to emergency services,

the AAH program is an alternative to inpatient admission. The model shifts care from facility-based to home-based care [8].

3. Teen Mental Health in Schools, a national school-based mental health literacy training program [13][14][15][10], was implemented locally as 'SMILES' in 2012. This is a program targeting educators to decrease stigma within schools and better provide support to students and improve educators' mental health knowledge and early identification skills.
4. The Initial Group Session for Families (IGS) introduces families to community child and family mental health services [11]. The IGS has been offered weekly since November 2016, as a standard of care and an expected step for families who, post-referral, have elected to enroll in community-based mental health services to address the mental health concerns within their families.

Methods

Each of the four innovations noted above was evaluated *via* a quasi-experimental design employing the same standard clinical measures and economic costing models. The clinical measures and economic costing models were the same for each evaluation, except for the SMILES program, which varied and was less controlled in its dissemination and implementation. For instance, SMILES was co-managed with the regional boards of education, and the unit of study was schools, compared to trained physicians (CanREACH), IGS, and AAH, wherein the unit of measurement was patients. These limitations and others, along with their origins in the planning and implementation processes for each project, will be discussed further below.

The costing model was based on the regional per diem financial department estimates for ambulatory and inpatient services. For inpatient services, this was a straightforward estimate based on length of stay (LOS). For ambulatory services, the length of stay did not reflect the direct costs of each day; rather, an estimate of the average clinic visits (e.g., 1/week) over the typical course of enrollment (10 weeks) was employed as a reference point and adjusted up or down for longer or shorter lengths of stay, respectively. In each service innovation or project, this standardized model was used. Additionally, in the case of SMILES, referral rates and clinical measures were the primary outcomes rather than an economic evaluation based on length of stay. This was mainly because implementation preceded the evaluation design, and the school attended at the time of referral had to be added to the regional information system post-implementation. To compound the late timing of adding the school attended variable, the boards ran ahead with implementation out of step with the planned three-month lead-in period to establish a

baseline referral rate for patients referred pre-exposure once the schools in the region were listed in the regional information system. In the case of schools, often staff from multiple schools would be trained at one time, which further complicated the collection of accurate data. This was not the case with the other projects, where most referring physicians exposed to CanREACH training had been listed as referral sources for years, which established a robust baseline referral rate. Similarly, the other two projects were situated in established emergency services (AAH) or clinics (IGS) where a flow of similar unexposed patients could be measured both before and after project implementation. The clinical measures were fully embedded in the regional information system long before the implementation of these four projects. The clinical measures are fully described in the individual papers devoted to the full description of each project [8][9][10][11] as well as in the papers describing the clinical measurement framework.

The clinical measures and the regional access and intake system (REGIONAL INFORMATION SYSTEM), wherein the data was gathered for all CAAMHPP services since 2002, have been fully described [16][17][18]. The outcome measurement system has been in place since 2002 and was fully developed in 2008 [16] [17]with the addition of the Adverse Childhood Survey in 2016 [19][20].

The quasi-experimental design employed to evaluate both clinical and economic impact used the same costing and clinical measurement models. The economic model is a standard reference, as noted above. The clinical measurement model was well established within the regional information system. The dataset permitted grouping individuals who were exposed or unexposed to each of the innovations across time. On this basis, within-group comparisons were made within exposed groups and unexposed groups over more or less the same time periods (the pre-post implementation time stamp). This permitted an assessment within and between groups of the effects of time alone compared to exposure to each innovation (before/after).

Data Analytic Procedures

The purpose of this paper is not to represent the detailed analyses of the published [8][9] and unpublished papers (SMILES & IGS), but rather the purpose is to summarize the observed clinical and economic outcomes and illustrate the research design. A graphic of the overarching model is presented to illustrate the design. The main outcome of each innovation was summarized in table form. This included a direct economic analysis for CanREACH and IGS, as these innovations were independent events and not operating in parallel to other CAAMHPP services; however, Smiles and AAH were represented as a reduction in LOS in relation to the most closely related program. For example, AAH primarily siphoned

presentations to emergency services and occasionally inpatient services. Admission rates post-AAH exposure were related to all available services.

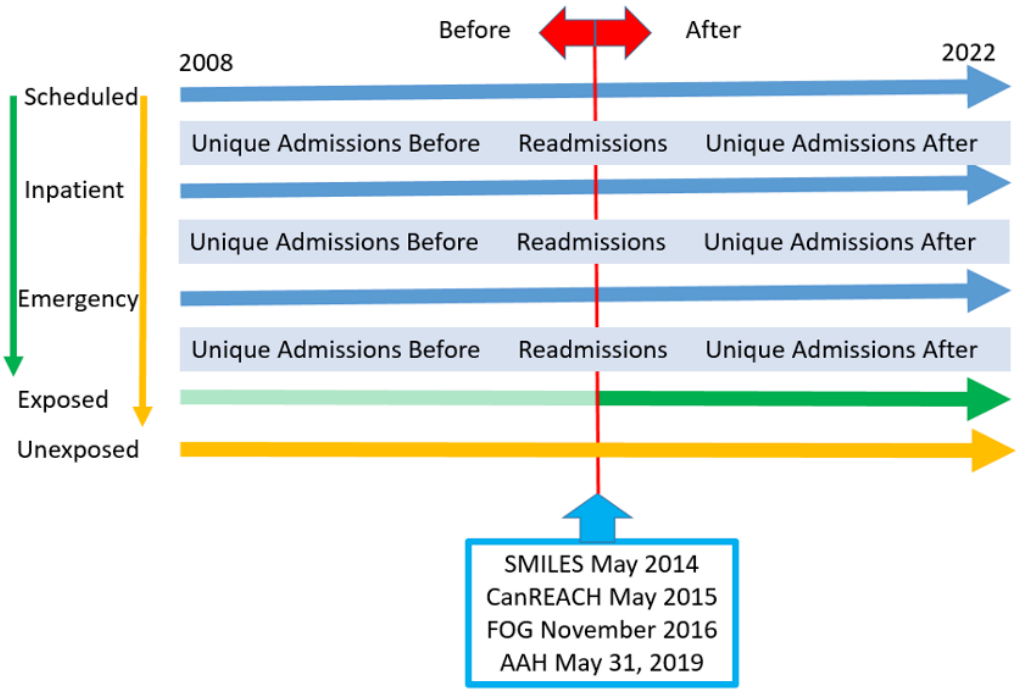

Figure 1. Research design

Figure 1 shows the overarching design for each of the projects. From Figure 1, the ability to compare those exposed and unexposed to each innovation is apparent. This ability isolates the innovation from the effect of time alone.

Results

Table 1 provides the following summary of findings comparing exposed and unexposed groups across the respective time intervals. The SMILES Go-To Educator training significantly changed the demographics, clinical profile, and treatment effects of students presenting to tertiary mental health services and substantially increased the referral rate of associated cases compared to untrained schools and schools pre-training. CanREACH primarily reduced the rate of referrals to emergency services at a cost of about 20,000 per trained physician, and the quality of referrals improved (e.g., more severe/urgent clinical profiles). The IGS-exposed group had a greater reduction in readmissions and cumulative length of stay compared to the unexposed group, with the greatest reduction in IGS-exposed emergency

admissions. Patients presenting to IGS were clinically equivalent to the unexposed group seeking service. AAH exposure reduced readmissions to any service by 30%, and exposed patients were clinically equivalent to comparable unexposed patients. Readers are encouraged to examine the published reports for the details of the calculations underpinning this summary.

Innovation	SMILES	CanREACH	IGS	AAH
Economic Savings* or %LOS or %Referral Change**	238% Increase in Referrals***	$2,932,112	$2,746,200	30% Reduction in re-admissions*
Clinic Comparison	Exposed Referrals More Severe/Urgent	Exposed Referrals More Severe/Urgent	Exposed Admissions ~ Unexposed	Exposed Admissions ~ Unexposed
Sample Size Exposed	25719	1081	6031	2603
Sample Size Un-Exposed	28439	2912	7622	18603
* Over Comparable Service (e.g., emergency/inpatient admissions) ** Reference to the improvement of referral clinical profile and reduction of admissions for referrals from exposed patients *** Baseline referral rates were not measured efficiently before the school was attended at the time the referral variable was added to the regional information system, and a management-based inefficient adherence to lead in that would have established a better baseline measure, hence only a smaller sample of schools was included in this analysis where a baseline was obtained.				

Table 1. Economic and clinical outcomes of the four innovations.

Discussion

The economic and clinical assessment models employed to evaluate the impact of four innovations within the CAAMPP system of care produced favorable results. The SMILES program was designed to improve mental health literacy in schools, and the increased referral rates appear to testify to this outcome. There is an economic burden related to increased rates of referral from any source; however,

given the longstanding identified unmet mental health service need for children and youth in communities across the country [21][22], this outcome was favorable. The CanREACH, IGS, and AAH innovations had the opposite effects. By virtue of the embedded program contents and activities, these innovations reduced admissions and readmissions to the extent in comparison to unexposed comparator groups over the same time period. These three innovations created a therapeutic space that had an estimable economic value. The CanREACH, IGS, and AAH innovations increased the available clinical 'space' for other referrals via the action of 'shaping demand' [18].

Limitations

As noted in the methods, the SMILES program was a partnership with the regional boards of education, and hence there was less control over the dissemination of this program. Furthermore, the implementation preceded the evaluation design, shortening the lead-in baseline measures (pre-exposure) of clinical profiles of referrals from schools. Presumably, the majority of youth attend schools, but it was not until implementation that specific schools were identified and tied to specific referrals within the regional information system database; hence, the unit of analysis was referrals from exposed and unexposed schools, not individuals. This planning oversight shortened the school-specific lead-in period. Additionally, the original roll-out plan included a minimum three-month lead-in period before training where baseline measures and referral rates could be estimated. In the enthusiasm to disseminate the program, this protocol was not adhered to strictly. This issue was remedied over time as only about half the schools were exposed over the study period. Yet there was another confounding issue. Traditionally, each year there is considerable migration between schools of both students and teachers. Hence, teachers trained at one school could move to another along with their attitudes, values, and skill sets, as with exposed students.

In comparison, the other three innovations were more discrete in that for CanREACH, the unit of analysis was, for the majority, a specific physician and less so a community-based allied professional making referrals to CAAMHPP. Many of the physicians trained had been making referrals for a long period before training, providing the lead-in pre-exposure dataset against which to compare not only their post-exposure referral rates but also the clinical measurement system embedded in the regional information system, which permitted measurement of the clinical profiles of their referrals [9][12]. IGS and AAH were similar to CanREACH in that the innovation was embodied in a tight unit within a specified program-linked intervention that did not migrate or become diffused across the system, rendering the unit of

analysis more clearly defined. For example, AAH was a clinical service accepting and diverting referrals in emergency services, and IGS was an intervention within a specific clinical service; the exposed referrals were highly trackable, and there was a long period of pre-exposure lead-in data available to compare, together with unexposed comparable services over the same time.

The economic indices used to evaluate two of the innovations (CanREACH and IGS) were a standard estimate of the cost of inpatient, emergency, and ambulatory services. This is most likely an underestimate of the total costs beyond direct care (e.g., overhead not related to direct care, such as building maintenance, housekeeping, energy, etc.). Nevertheless, the same index was applied to both innovations, making them most comparable in economic terms. While referrals themselves (SMILES) also provided an indicator of potential cost, there would be considerable cost variance depending on the clinical services into which clients were received (e.g., ambulatory *vs.* inpatient). The AAH analysis stopped short of measuring the precise economic impact of the 30% admission reduction compared to emergency services, as AAH operated in parallel to emergency services, basically siphoning emergency presentations that met inclusion criteria that were slightly less severe than those admitted to inpatients following presentation. This inclusion criteria, even though the overall clinical profile of emergency and AAH admissions were similar, would constitute a structural bias or difference in terms of the exposed group.

A consistent limitation across not only these four projects but also over a series of funding rounds between 2002 and 2018, which in essence tripled the child mental health budget, was that it substantially failed to triple capacity or even bring capacity within any range of servicing the estimated number of children and youth in the catchment who were functionally impaired [18]. These were, for the most part, provincial funds, with some funds coming for these projects from the regional children's hospital foundation. While the system of care was fortunate enough to have a robust clinical outcome measurement embedded in the regional information system for the purpose of evaluation, operationally it was and remains in later years by and large an afterthought on the part of directorship to consider including the evaluation cycle at the project or innovation design phase. In fact, to date, many projects suffer from a timidity endemic to large organizations and a tendency not only to maintain but to reinvent the status quo, rather than move in directions that would further shape demand [18] and upregulate the system's ability to service unmet children's needs, such as developing virtual reality and artificially intelligent (VRAI) assessment and treatment models [23].

Implications for Health Care Provision and Use

The foregoing provides four examples of innovations with varying foci. SMILES was a school system-wide innovation that proved to be more diffuse in terms of implementation and the unit of measurement (school) than the other three innovations, which led to less measurement precision. The economic index used for CanREACH and IGS represented the innovations that were closest to the ideal of employing a standard economic index and evidence-based clinical measures [5]. The AAH innovation was close to this and likely requires further investigation.

Implications for Health Policies

We have demonstrated the economic impact in two of the four innovations (CanREACH and IGS) and have come close in the AAH innovation. Cornerstone to this achievement is having a definable group that is exposed to an innovation with a clear lead in pre-exposure and a comparable unexposed group measurable in both economic and clinical terms over the same time. A common economic cost index (inpatient and ambulatory), an embedded clinical measurement system [16][17] and mostly a centralized tracking system [18] were key to this demonstration.

Community-level inter-system (Health and Education) projects, as in the SMILES innovation, proved to be more diffuse and less controllable with less definable groups that nonetheless had exposed and unexposed group cross-over, being subject to real-world influences that by their nature obfuscate the ability to measure economic impact directly.

Implications for Further Research

Investigation of innovations or standards of care requires established measurable economic indices in addition to valid and reliable clinical measures as the basis of evaluating economic impact. When innovations are most directly comparable, such as in the case of CanREACH and IGS, it is possible to ascertain the next step. For example, of the two innovations that had the greatest economic impact. At this point, it is possible to establish the cost-benefit ratio of implementation. CanREACH was more expensive, having a team of physicians and a coordinator training small groups of physicians over the course of the implementation. IGS had two regular staff who led an Initial Group Session for Families once a week within the context of a community clinic. Both had similar economic impacts in terms of currency. These two groups had very different and not altogether comparable objectives other than serving the concept of ‘shaping demand’ [18], in other words, creating a ‘clinical space’ into which those in

greater need might flow to access services. Even though these programs were different, the ability to directly compare them both economically and clinically would inform a system of care that it would be most expedient to first implement the one that cost less to implement (IGS), even though that might not foreclose on the need to implement the other.

Ethics

Review by the Calgary Human Research Ethics Board.

Study conducted under Ethics ID: REB14-0566

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Declarations

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