

## Measuring Interactions Among Research Grant Recipients through Social Network Analysis: Insights into Evaluating and Improving Research Collaborations

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**Abstract:** *Alberta Health Services (AHS) was awarded a grant from the Alberta Ministry of Human Services to promote applied mental health research within areas of interest to the Ministry. The grant funded the Collaborative Research Grant Initiative: Mental Wellness in Seniors and Persons with Disabilities (CRGI), designed to collaboratively generate knowledge to improve the effectiveness of programs, services, and supports for the mental health needs of seniors and adults with disabilities. CRGI researchers received support via workshops that provided grant process information and basic research instruction, as well as an annual conference to share research results and network with each other. We used social network analysis to assess whether CRGI objectives regarding collaboration were achieved and to provide examples of possible future strategic planning. A survey of grant recipients with questions addressing collaboration before and after CRGI events was also completed. Awareness among grant recipients increased drastically from before and after the CRGI. Information workshops and the conference both provided successful support and increased awareness of ongoing work among grant recipients.*

**Keywords:** *Social network analysis, collaboration support, knowledge exchange, research grant evaluation*

### Introduction

This project aimed to assess how a major collaborative research grant initiative affected interactions among grant recipients. The *Collaborative Research Grant Initiative: Mental Wellness in Seniors and Persons with Disabilities* (CRGI) was funded by a grant awarded by the Alberta Minister of Human Services to Alberta Health Services-Addiction & Mental Health. The CRGI had two main goals. First, it funded both academic and practitioner-driven research designed to assist individuals living with a mental illness and disabilities to maximize their independence in the community. In addition, the CRGI was meant to increase awareness of Alberta-based research, and foster collaboration and knowledge exchange, among policy makers, researchers, and community agencies. Developing research collaborations across multiple organizations,

disciplines, and locations is a complex challenge and requires significant support (Craven & Bland, 2006). Researchers have argued that we must demonstrate effective knowledge exchange practices in order to better understand what forms of support are effective under real world conditions (Norman & Huerta, 2006).

The CRGI steering committee agreed that a first step toward enhancing collaboration within Alberta was to increase awareness among practitioners and researchers in the mental health field. Several information sessions and knowledge exchange events were held to support potential research grant applicants through the CRGI application process, to encourage collaboration, and to disseminate research results. Activities important to the Ministry included capacity building within community agencies funded by the Ministry; capacity building within the Ministry itself; and multi-sectoral collaboration. The CRGI steering committee also decided to evaluate the effectiveness of the workshops using social network analysis. This paper focuses on the social network analysis results, based on data collected from 26 CRGI participants who were surveyed. The project aimed to assess effects of the CRGI on collaboration between grant recipients and their knowledge of one another's work. Therefore we also aimed to illustrate which components of the CRGI were affective in achieving the Ministry's goals. The survey asked grant recipients for demographic information, through which CRGI activities they had met, and about their collaborative activities with one another before and after winning a CRGI grant and engaging in related events. We include information regarding support activities below and further details regarding the grants, projects awarded funding, and the activities that were undertaken to support their collaboration are available at the Alberta Addiction & Mental Health Research Partnership Program website (<http://www.mentalhealthresearch.ca>).

### **Social Network Analysis**

Social network analysis (SNA) is the study of the structure of relations between actors, people, or organizations who have the capacity to take action (Wasserman & Faust, 1994; Scott, 2000). Key SNA principles include: actors are interdependent; resources such as information can be transferred between actors via the nature of their relationships; the form that relationships take between actors can limit or enable the capacity for individual action and; models of networks—their structure—are considered as regularly occurring patterns of relationships between actors within a network (Wasserman & Faust, 1994). In SNA, structure is often illustrated using sociograms or graphs where points (typically actors) are connected by lines (relations) (Scott, 2000). In other words, a sociogram is a graph that represents the people within a social structure and their connections to their peers. These graphs can be effective in visualizing what a network looks like by allowing relations to become visually observable in situations where the observation is typically theoretical or ephemeral.

Social network analysis is a useful means to examine interdisciplinary collaboration (Stokols et al., 2003; Godley, Barron, & Sharma, 2011; Godley, Sharkey, & Weiss, 2013). For example, a comparison of individual attributes and network structure can provide valuable information regarding changes in interdisciplinary cooperation over time (Aboelela, Merrill, Carley, & Larson, 2007). Social network analysis can also be applied to facilitate collaborative innovation and

knowledge exchange by elucidating structure and qualities of collaborator networks (Hargadon, 2002), examining how particular characteristics of collaborations affect performance (Thomas-Hunt, Ogden, & Neale, 2003), or revealing forms of collaboration between actors most likely to be productive and maintained (Provan, Harvey, Guernsey de Zapien, 2005; Long, Cunningham, Wiley, Carswell, & Braithwaite, 2013).

For example, Aboelela et al. (2007) used SNA to evaluate a Centre for Interdisciplinary Research on Antimicrobial Resistance (CIRAR). They designed questionnaires to ask participants about their knowledge of others involved in the collaboration, as well as the types of work they engaged in with each other. Surveys were administered at the beginning of the group's formation and at 6 and 12 months afterward. By examining changes in disciplinary network composition over time, Aboelela et al. (2007) were able to determine whether the goal of facilitating interdisciplinary research was accomplished. Results demonstrated that after one year of CIRAR's existence, the network ceased to be dominated by participants from medicine and nursing and became composed of a variety of other disciplines. Aboelela et al. (2007) found that the most productive network members were highly connected to others and positioned between many others (bridges), making them potentially good facilitators for the transfer of information and building new connections.

While there have been a number of studies identifying leadership in networks (Long, et al., 2013), exchange of specific information (Wensing, Lieshout, Koetsenruiter, & Reeves, 2010), or implementation of specific evidence based practices (Palinkas, et al., 2011), this current project provides evidence of effective support for enhancing awareness as a first step in building connections between otherwise isolated potential collaborators. As such, this paper provides useful insights for major research grant evaluation, knowledge exchange, and collaboration building practices. We assess CRGI member connectedness and awareness before the CRGI, determine which of the CRGI activities were effective at enhancing awareness of research among CRGI research grant recipients (if any), and describe what changes in networks occurred in relation to the CRGI. The research questions we used to guide this process are: 1) How well integrated were CRGI network members prior to the CRGI-related activities?; 2) Did CRGI activities affect integration?; 3) What changes in relationships among network members occurred after CRGI related activities?

## **Research Methods**

In order to examine the links and relationships between members of a bounded population it is important to survey as complete a network as possible (Heath, Fuller, & Johnston, 2009). Missing responses from central or influential members of a social network can result in a distorted representation (Quatman & Chelladurai, 2008). Hence, SNA research generally does not employ random sampling (Quatman and Chelladurai (p. 348, 2008). We used purposive sampling in our surveys to ensure that all grant recipients possessed the required characteristics for the purposes of our study (Cohen, Lawrence & Morrison, 2007). Survey data are typically used for SNA and have been found to produce reliable results (Marsden, 1990).

Within the CRGI there were 37 research grant recipients. Three grant recipients were excluded from this study due to illness, maternity leave, or retirement. This is not a detrimental flaw, since

our goal was to evaluate CRGI activities for all *active* grant recipients. Of those 34 individuals, 27 research grant recipients provided consent to participate in the study. One person who consented subsequently did not respond, leaving us with 26 study participants and a response rate of 76.5%. Our response rate is considered acceptable for SNA and is high enough to limit effects of missing data (Wasserman & Faust, 1994). Moreover, we tracked which grant recipients participated in our study and to our knowledge no particularly influential or central research grant recipients did not participate. Half of the study participants were male and half were female. They were generally aged 40 or older, with the majority being primarily involved in mental health as researchers, academics, or service providers. See Table 1 for the full demographic profile of participants.

Network studies with a small sample size run the risk that study participants can be identified when attributes are included because readers can combine relationships illustrated in sociograms with attribute data and publicly available information (e.g., via websites). We mitigated this problem by including attribute data in the aggregate in our tables, and only illustrating gender and career stream within mental health related work. We did not identify the specific organization with which our participants are affiliated. Study participants were informed of the risks associated with participation in this study and ethics approval was obtained from the former Community Research and Ethics Board of Alberta (CREBA).

Study participants are located throughout the province of Alberta and are familiar with electronic communication with the grant administrators. Because of participant's geographically distributed work it was practical to conduct an online survey. Participants were asked to indicate their relationship with each of the other research grant recipients out of a possible number of 27 (see Appendix A). Four levels of relationship were examined, whether he/she had heard of, knew the work of, had worked with, or had met with others. Respondents who indicated that they had met or collaborated with another grant recipient were prompted to specify how and a list of options were provided. Options for how they had met included: CRGI information sessions and workshops or an annual knowledge exchange conference. Options for whether they had collaborated included: whether they co-authored a paper, co-presented at a conference, shared knowledge, or won a

Table 1. Grant Recipient Demographics

Characteristic	Frequency (%)
<b>Gender</b>	
Male	13 (50%)
Female	13 (50%)
<b>Age</b>	
29 years or younger	0 (0%)
30-39 years	3 (12%)
40-49 years	6 (14%)
50-59 years	10 (40%)
60 years or younger	6 (24%)
<b>Primarily involved in mental health work as</b>	
Researcher	14 (54%)
Administrator	1 (4%)
Service Provider	8 (31%)
Policy/Decision Maker	1 (3%)
Others (Manager, Quality Practice Lead)	2 (8%)
<b>Affiliation</b>	
Community Agency	7 (33%)
Academic	14 (67%)

grant together. The survey was administered before the final CRGI event, but grant recipients were asked questions related to relationships with fellow CRGI researchers both *before* as well as *after* the CRGI events were completed. There were additional events that were held later in the CRGI program, but a number of major events were completed within the scope of this current project. We acknowledge this limitation and further discuss it in the limitations section. Because of the short time interval from the CRGI events to the questionnaire forgetting of “before” and “after” relationships and cross contamination was minimized. Marin (2004) found that network survey respondents are more likely to effectively remember connections with individuals when they have had more types of relationships, and when they have known one another for longer periods of time. Participants who knew one another from “before” the CRGI are likely to have had longer lasting relationships and be more memorable to one another. Whereas respondents who met “after”—through the CRGI—had their memories reinforced by significant events such as: attending the CRGI workshops, winning the grant competitions, and attending the annual conference with its various networking events. Moreover, because our survey was with a whole network each respondent did not have to generate names through a free recall task, but were given a list of all possible names for each network question. All of these characteristics of our study contribute to confidence that respondent memory is not a confounding factor in our study. Respondents were also asked to identify how they were primarily involved in mental health work (see Table 1 above for participant demographics). In order to track who had completed the survey, grant recipients were also asked to report their gender, age, and name.

Once data were collected they were exported from the online survey software and imported into UCINET for analysis (Borgatti, Everett, & Freeman, 2002). UCINET is software that was developed specifically for the purpose of analyzing network data. We used UCINET to examine density, degree, and isolates, a form of descriptive analysis that does not typically integrate common statistical procedures such as tests of significance. However, we also used UCINET to compare the differences in density before and after involvement in CRGI activities and events. UCINET uses a bootstrapping procedure to take multiple samples (5,000) from the data and then calculate a classical *t*-test of significance. This procedure is useful for determining changes in density among the same set of actors for the same set of relations over time. UCINET is also fully integrated with NetDraw software for visualizing networks. This allowed us to visually analyze graphs for patterns and changes in networks and to use these visualizations to reflect on post-evaluation strategic action. We did not consider direction of ties in our analysis, as some other SNA studies have done, because our focus was on the overall increase in ties for those who took part in CRGI activities.

## Results

Our first research question asked how well integrated CRGI network members were prior to CRGI related activities. To answer this question we examined the degree of overall relations in the network before the CRGI by looking at degree, isolates, and density of the network. These measures are illustrated in Table 2 for the ties “have heard of”, “knew their work”, and “have met”, as well as a multiplex network of all of these ties combined. Of particular interest is the tie “knew their work”, illustrated in Figure 1, because it is the most meaningful connection for potential

future collaboration. One may have heard of, or have met another individual, but still be ignorant of their research. In the absence of knowing another potential collaborator’s work, one would be unlikely to approach them to collaborate on a project. For “knew their work”, the network density was 3.7%, indicating that only 3.7% of all potential ties in the network existed at baseline. Fourteen individuals knew nothing of other research grant recipients’ work prior to CRGI (53.8%). The highest degree for the “knew of” network was 6, showing that the most connected person only knew the work of 6 other individuals.

Our second research question asked if CRGI activities affected integration. Again, we examined degree, isolates, and density for the CRGI event networks. Opportunities to meet at the CRGI were organized around sharing information regarding grant recipient research and other related work. In order to clarify which of the CRGI events had been particularly useful in introducing grant recipients we asked those who met through our events to identify the event where they had

Table 2. Baseline Network Measures

	Density %	Isolates	Mean degree	Sd	Min degree	Max degree
Have heard of	8.6	4	2.154	2.178	0	10
Knew their work	3.7	14	0.923	1.385	0	6
Have met	7.7	8	1.923	2.074	0	8
Multiplex before	0.185	3	4.615	3.431	0	26

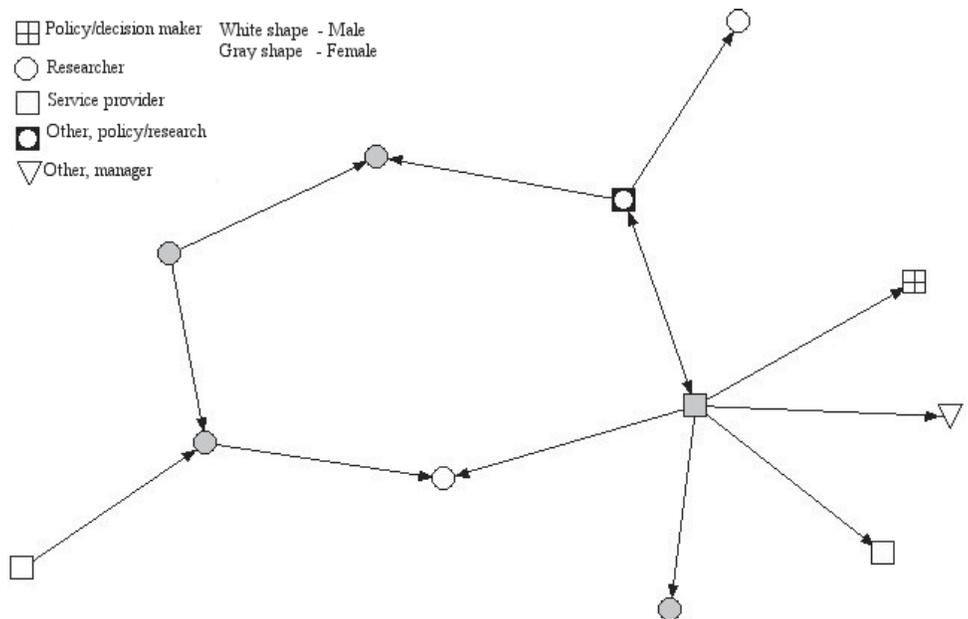


Figure 1. Baseline Sociogram for “knew their work” Network

met one another. Results for the CRGI workshops and annual conference events are provided in Table 3 and illustrated in Figures 2 and Figure 3, respectively. While the density of the CRGI workshops network was relatively low (5.5%) we can say the event was successful in that there were only 12 isolates, a combination of grant recipients who already had met prior to the sessions (as per research question 1), or at our other event illustrated in Figure 3. Similarly, the annual conference event was successful in bringing people together as the density increased over that of the workshops (7.4%), there were fewer isolates (4), and there was an increase in maximum degree from before and after the workshops.

Our third and final research question asked what changes in relationships among network members occurred after CRGI related activities. It was asked to help clarify the overall success of CRGI efforts to introduce grant recipients to each other and to increase awareness of their work. Network measures for research question 3 are displayed in Table 4 and illustrate that there was a sharp increase in all network measures of inter-grant recipient connection and a decrease in the number of isolates. After the CRGI workshops and conference all grant recipients had at least heard of one other grant recipient, at least one individual had heard of nearly all of the grant recipients, and density increased to 22.8% (from 8.6%). For the “have heard of” network,

Table 3. CRGI Event Networks Measures

	Density %	Isolates	Mean degree	Sd	Min degree	Max degree
CRGI information workshops	5.5	12	1.385	2.114	0	8
Found in translation	4.7	4	1.846	2.231	0	11

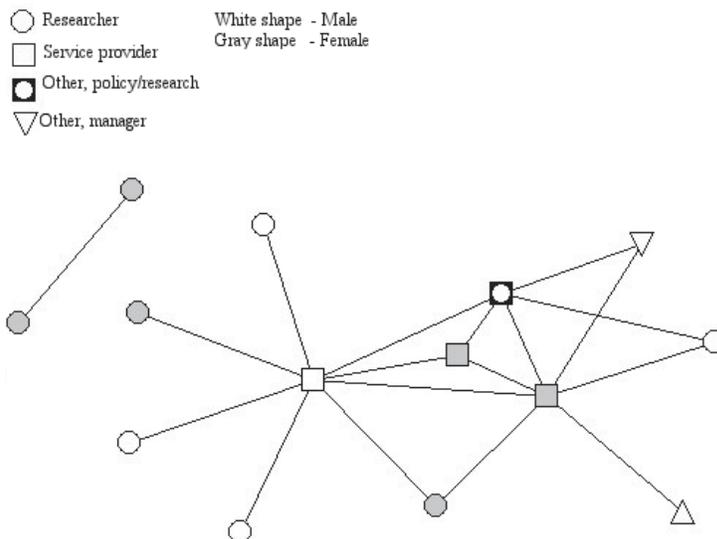


Figure 2. Sociogram for CRGI Workshop

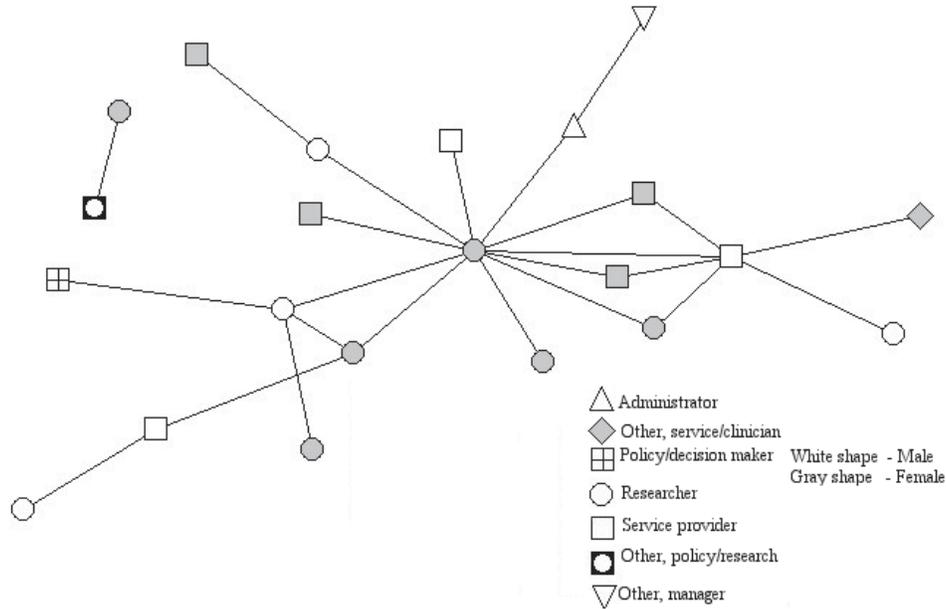


Figure 3. Sociogram for CRGI Conference

22.8% of all possible ties had been made (not illustrated). For the “had met” network, one isolate remained, but 13.8% of all possible introductions had been made, an increase of 6.1% over the pre-CRGI situation (Figure 4). For the “know of” network one isolate remained, and 16.6% of all possible connections had been made, an increase in density of 12.9% over baseline (Figure 5).

Finally, the multiplex network is composed of all possible ties and demonstrates that 47.4% of all possible ties had been made (an increase in density of 47.2%); at least one person had been tied to every other possible individual in some way (Figure 6). Examining Figure 6 and Figure 7 provides a comparison of all possible ties before and after the CRGI (respectively) and illustrates the significant increase in number of connections between baseline and conclusion. All differences in density from baseline were statistically significant ( $p < 0.05$ ). Our results demonstrate that overall, the CRGI was successful in achieving its goals of increasing awareness of Alberta-based research among our grant recipients.

Table 4. Post-CRGI Event Network Measures

	Density %	Isolates	Mean degree	Sd	Min degree	Max degree
Have heard of	16.6	1	4.154	4.312	0	21
Knew their work	13.8	1	3.462	3.066	0	14
Have met	22.8	0	5.692	5.312	1	23
Multiplex before	0.474	0	11.846	6.0363	4	25

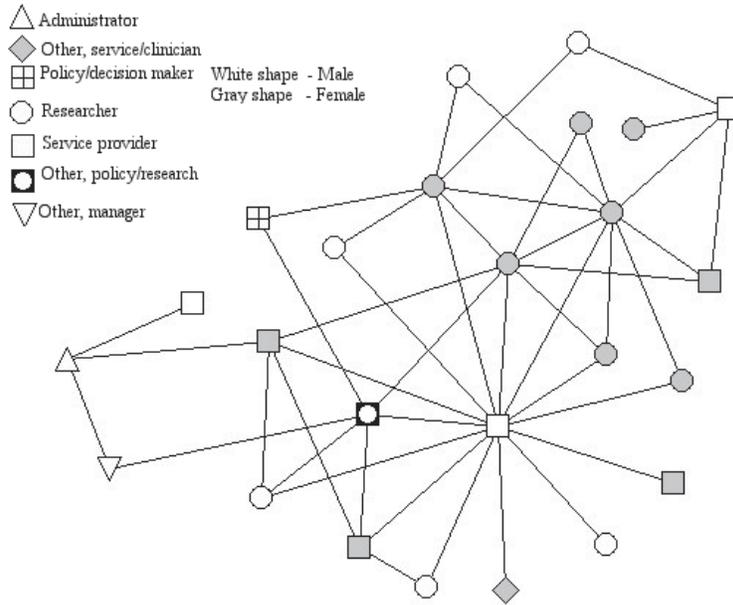


Figure 4. Sociogram for “have met” After CRGI Events

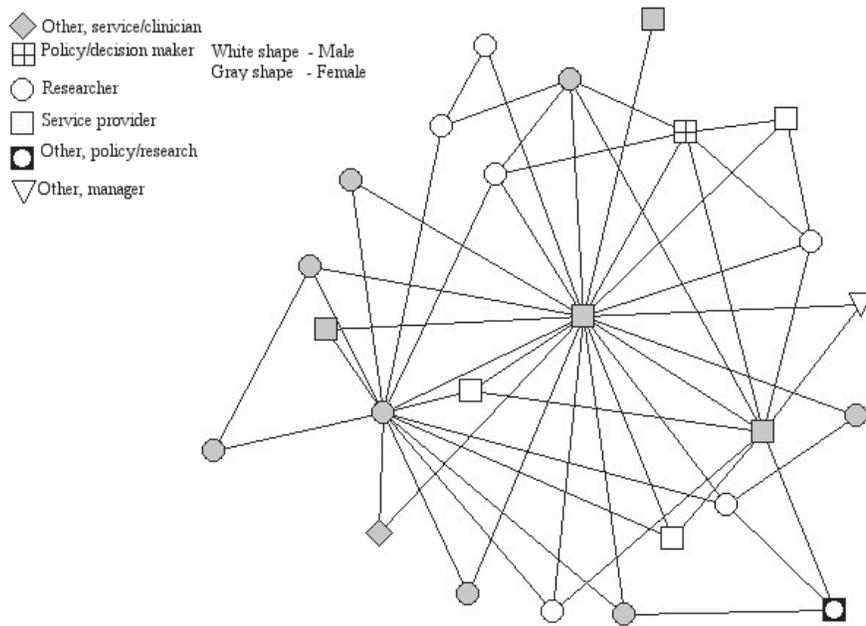


Figure 5. Sociogram for “know their work” After CRGI Events

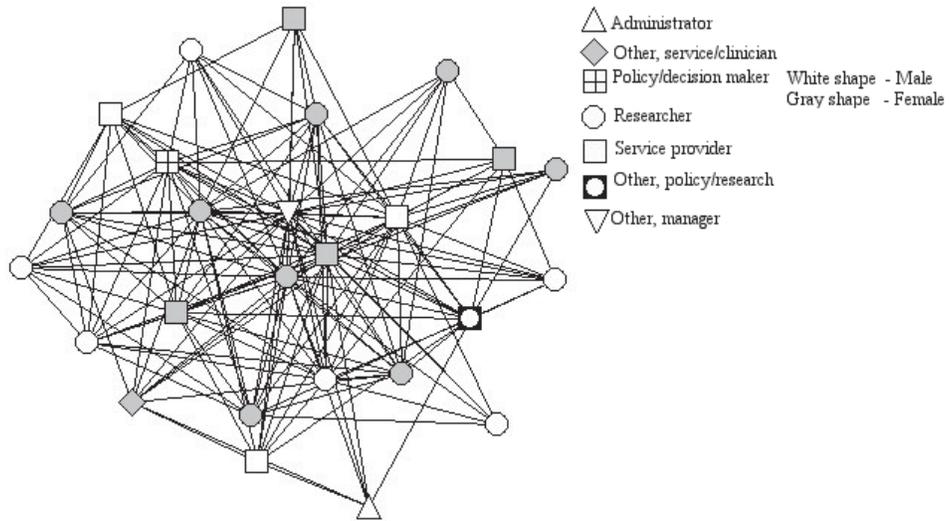


Figure 6. Sociogram for All Relations After CRGI Events

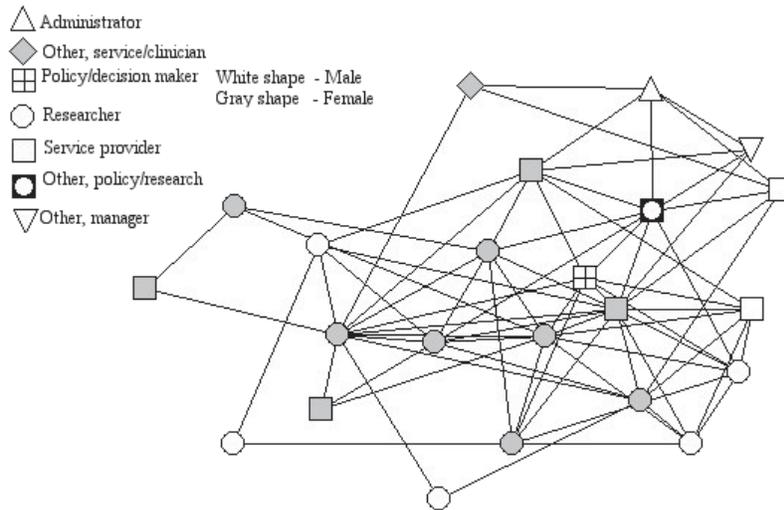


Figure 7. Sociogram for All Relations Before CRGI Events

## Discussion and Conclusions

Opportunities for research grant recipients to meet face to face were organized around sharing information regarding grant recipient research and other work. Our survey results regarding which activities may have affected integration (Table 2 and Figures 2 & 3) demonstrate that the events were successful and the annual conference further enhanced the relationships between grant recipients overall.

Research administrators interested in using information derived from network analysis will find it is most useful when combined with a strategic vision of organization goals. Beyond merely tracking progress toward those goals, it can also be used to identify strengths or, alternatively, areas in need of improvement in order to adapt activities toward achieving objectives (Aboelela, Merrill, Carley, & Larson, 2007). We provide an example of such network engineering by focusing on the objective of building more meaningful relationships between research grant recipients. Second, we use our network graphs to demonstrate how to identify key network members and how we might have used information about differences between types of relationships in order to achieve organization objectives.

One of the primary goals for the CRGI was to increase meaningful relationships among mental health researchers in Alberta. While this study has demonstrated that this goal was achieved, it would be possible to use these analyses in order to further engage in strategic intervention to build even more meaningful relationships between its grant recipients over time. For example, we recommend finding individuals who are connected through “have met” or “heard of” and further connecting them through knowledge of one another’s work (Norman & Huerta, 2006). Another approach would be to determine individual relationships in order to pinpoint which people might play a key role in implementing research based practices, but this would not be possible in the absence of any knowledge regarding what research is available for translation (Palinkas et al., 2011).

Research has demonstrated that individuals with a high degree of centrality can be useful in taking on leadership positions (Long, et al., 2013). Thus, well connected individuals can assist in building future collaborations and sharing important information. The “know of” sociogram (Figure 5) is of particular interest to our potential strategic planning for network engineering. In our “know of” network, the research grant recipient represented by the gray square in the center of the sociogram is a “star” in that the person knows the work of many other individuals, including service providers and researchers. Relative to having heard of, or met others, knowing others’ work is a particularly strategic relationship in that this knowledge is important for identifying common interests among our grant recipients. This research grant recipient could play a particularly important role identifying potential future collaborators and facilitating their work. Figure 5 also contains other valuable information. This grant recipient’s occupation is as a service provider which in combination with her knowledge of research and connections to other researchers or service providers can allow her to play an important role in moving research to practice. Future work with the CRGI could also examine the networks for betweenness centrality, which provides a measure of the shortest path between actors and may indicate the most effective means of brokering new relationships. Godley, Sharkey, and Weiss (2013) used these network measures to identify leaders in networks of neuroscientists at a university brain research institute. A research

administrator could easily make use of such information to broker relationships between leaders and other network members, to disseminate information, or to achieve other goals.

Our aims for this study were to use social network analysis to review the success of a collaborative research grant initiative in meeting its goals of increasing research awareness and connecting grant recipients from diverse disciplines and organizations across Alberta. We also provided some examples of potential strategies for future network building. Both the CRGI workshops and annual conference events helped facilitate Ministry goals. Research administrators will likely find that building support into research grants, such as workshops that provide an overview of available grants and the application process or conferences that incorporate networking activities, will likely enhance research awareness and collaboration in other collaborative grant initiatives.

Some limitations of this study include that our survey was administered at one point in time, rather than at several time points. Having measures at more than one point in time may have allowed us to provide a more nuanced analysis and reduced the possibility of memory failure in our participants. Administering the survey at only one time point was due to our funding requirements. The survey had to be administered before the end of the grant term and two more networking events occurred after our survey. Our results likely under estimate the degree to which the CRGI increased awareness and collaboration among grant recipients. Moreover, we were unable to follow up and test future strategic planning for our research networks and we could not examine the specific types of collaborations that resulted from the CRGI. Additionally, we were only able to achieve a response rate of 76.5%. For network analysis, having full member participation is important for understanding network dynamics. Missing a key influential individual may also have implications for using SNA for strategic planning. However, in our study we did know all potential participants and to the best of our knowledge none who were particularly influential or central did not participate. Future research should examine long term outcomes of collaborative research grant initiatives. Also, whereas we examined a broad network building intervention—the annual conference event—future research might more closely examine specific elements of such an event to consider their individual utility. Despite these limitations, our results demonstrate that overall, the CRGI was successful in achieving its goals of increasing awareness of Alberta-based mental health and disability research among our grant recipients and bringing them together to foster future collaboration. In addition, our results demonstrate the value of social network analysis for evaluation of the effectiveness of CRGI type initiatives.

### **Author's Note**

Gary Barron holds bachelors degrees in sociology and psychology, a master's degree in sociology and is a doctoral candidate in the Department of Sociology at the University of Alberta. He is a social research methodologist with interests in the sociology of knowledge, health and illness, mental health and illness, quantification and statistics. Heather Scarlett-Ferguson holds a bachelor of science in pharmacy, a master's degree in education and is a doctoral candidate in the Centre for Distance Education at Athabasca University. She is a knowledge exchange expert working in Management at Alberta Health Services - Addiction & Mental Health. Cathy Aspen holds a bachelors degree in management and master's degree in science (management). She is a research coordinator for Alberta Health Services- Addiction & Mental Health. Funds dispersed through the Collaborative Research Grant Initiative were provided by the Alberta Ministry of Human Services. The CRGI was administered and evaluated by Alberta Health Services- Addiction & Mental Health. Alberta Health Services was an institutional partner on this project. The Grant that supported this project was provided by the Alberta Ministry of Human Services as part of the Collaborative Research Grant Initiative: Mental Wellness in Seniors and Persons with Disabilities. In kind support for the grant was provided by the Alberta Addiction & Mental Health Research Partnership Program. Correspondence concerning this article should be addressed to Heather Scarlett-Ferguson, Manager, Knowledge Exchange, Alberta Health Services, Centennial Centre for Mental Health & Brain Injury, Box 1000, Ponoka, Alberta, Canada, T4J 1R8.

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## Appendix A – Network Survey

### MODIFIED ONLINE SURVEY

Please indicate whether you have “heard of,” “know,” “met,” or “collaborated with” for each of the individuals listed for each scenario.

*Think about before you applied for a CRGI Research grant...*

1. Did not you know this person, skip to next person
2. Had you heard of
3. Knew their work
4. Had met
5. Had collaborated with
  - a. Co-applied and won a research grant with
  - b. Co-presented at a conference with
  - c. Shared knowledge with
  - d. Wrote a journal article with
  - e. Other \_\_\_\_\_

*Now think about today and after you received a CRGI Research grant...*

1. Do not know this person, skip to next person
2. Have you heard of
3. Know their work
4. Have met
5. If you’ve met, where?
  - a. CRGI Information sessions/workshops
  - b. Found in Translation
  - c. Other \_\_\_\_\_
6. Have you collaborated with them?
  - a) Co-applied and won a research grant with
  - b) Co-presented at a conference with
  - c) Shared knowledge with
  - d) Wrote a journal article with
  - e) Other \_\_\_\_\_