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Evaluating the impact of a Critical Time Intervention adaptation on health care utilization among homeless adults with mental health needs in a large urban centre

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Key Words:	Critical Time Intervention, Case management, Homeless, Mental Health Services, Addictions, Healthcare utilization

Abstract:	Objective: This study evaluated the impact of a Critical Time Intervention (CTI) adaptation on health care utilization outcomes among adults experiencing homelessness and mental health needs in a large urban centre. Method: Provincial population-based administrative data from Ontario, Canada were used in a pre-post design for a cohort of 197 individuals who received the intervention between January 2013 and May 2014 and were matched to a cohort of adults experiencing homelessness who did not receive the intervention over the same time period. Changes in

	health care utilization outcomes in the year pre- and post-intervention were evaluated using generalized estimating equations and post-hoc analyses evaluated differences between groups. Results: Pre-post analyses revealed statistically significant changes in health care utilization patterns among intervention recipients, including reduced inpatient service use and increased outpatient service use in the year following the intervention compared to the year prior. However, the matched cohort analysis found non-significant differences in health service use changes between a subgroup of intervention recipients and their matched counterparts. Conclusions: An adapted CTI model was associated with changes in health care utilization among people experiencing homelessness and mental health needs. However, changes were not different from those observed in a matched cohort. Rigorous study designs with adequate samples are needed to examine the effectiveness of CTI and local adaptations in diverse health care contexts. Abstract.docx

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Title

Evaluating the impact of a Critical Time Intervention adaptation on health care utilization among homeless adults with mental health needs in a large urban centre

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Abstract

Objective: This study evaluated the impact of a Critical Time Intervention (CTI) adaptation on health care utilization outcomes among ~~homeless~~ adults experiencing homelessness and~~with~~ mental ~~illness~~ health needs in a large urban centre.

Method: Provincial population-based administrative data from Ontario, Canada were used in a pre-post design for a cohort of 197 individuals who received the intervention between January 2013 and May 2014 and were matched to a cohort of ~~homeless~~ adults experiencing homelessness who did not receive the intervention over the same time period. Changes in health care utilization outcomes in the year pre- and post-intervention were evaluated using generalized estimating equations and post-hoc analyses evaluated differences between groups.

Results: Pre-post analyses revealed statistically significant changes in health care utilization patterns among intervention recipients, including reduced inpatient service use and increased outpatient service use in the year following the intervention compared to the year prior. However, the matched cohort analysis found non-significant differences in health service use changes between a subgroup of intervention recipients and their matched counterparts.

Conclusions: An adapted CTI ~~improved~~ model was associated with changes in health care utilization among ~~homeless~~ people~~-~~ experiencing homelessness and~~with~~ mental ~~illness~~health needs. However, changes were not different from those observed in a matched cohort. Rigorous study designs with adequate samples are needed to examine the effectiveness of CTI and local adaptations in diverse health care contexts.

Keywords: Critical Time Intervention, case management, homeless, mental health services, addiction, health care utilization

1. Introduction

Internationally, rates of homelessness continue to rise[1,2]; and in Canada, national data show an increase in demand for shelter beds over time, with at least 235,000 Canadians experiencing homelessness in a year[3]. ~~Homeless individuals~~People experiencing homelessness also experience higher rates of mental health and addiction challenges[4~~1~~], neurocognitive impairment[5,6~~2,3~~], physical health problems and premature mortality[7,8~~4~~], compared to their housed counterparts. Despite the health disparities, this population generally has limited access to appropriate, high quality health care and supports, even in settings with universal health insurance[9~~6~~-12~~9~~]. Together, these factors contribute to high rates of hospital service use and costs[13~~10~~-16~~13~~].

~~With rising rates of homelessness in Canada and internationally[14-16]~~ ,Given increasing rates of homelessness and the impact of homelessness on health[17], t ~~t~~here is an urgent need for interventions to improve health outcomes in this population, including avoidable hospital service utilization[15~~12~~]. Fo~~Fo~~r adults experiencing ~~homelessness and~~ mental illness, care following discharge from hospital for a mental health condition is reportedly the most important factor in reducing reliance on subsequent inpatient care[18~~7~~]. ~~Yet this population~~Adults experiencing mental illness and homelessness, however, are ~~is~~

less likely to be referred to and access community-based services upon discharge from hospital, compared to housed individuals[1~~9~~8,20~~19~~].

Among ~~homeless populations~~people experiencing homelessness, strategies to improve continuity of care by offering intensive time-limited services to support the transition from hospital to community-based services have shown promising findings[2~~1~~0-26~~5~~]. Critical time intervention~~s~~ (CTI) was designed to support homeless individuals during transitions of care, including the period post-hospital discharge in which people experiencing mental illness are at high risk of experiencing first-episode or recurrent homelessness ~~in particular, offering~~ .[27,28] Critical time interventions involve time-limited intensive case management over a period of six to nine months and aim to help service users navigate the complex service system and establish (or re-establish) access to longer-term community-based connections, resources and interventions. This particular model, ha~~s~~ve been shown to decrease early psychiatric readmission rates[2~~4~~3,29~~6~~,30~~27~~], improve perceived quality of care[2~~2~~1,2~~5~~4], ~~and~~ improve health and quality of life outcomes[2~~4~~3,30~~27~~], and reduce rates of homelessness[27,31]. Past evaluations of CTIs have also suggested that this approach is cost-effective[32~~28~~] in supporting transitions of care.

More evidence of the impact of CTI models, and their adaptations in diverse settings, is urgently needed to support implementation of effective and cost-effective

strategies to improve health and housing outcomes among people experiencing homelessness and who have unmet mental health needs. A recent pre-post evaluation of a CTI adaptation for ~~homeless adults~~adults experiencing homelessness and mental health needs who were transitioning from hospital to community services in Toronto, Canada, reported significant improvements in mental and physical health, substance use, and quality of life in the six months following the intervention[24~~3~~]. Expanding on this work, the primary objective of this study was to use administrative health care utilization data to evaluate whether a brief CTI adaptation for ~~homeless adults~~adults experiencing homelessness and mental health needs who were discharged from hospital services was associated with significant ~~improvements~~ changes in health care utilization outcomes in the year post-intervention compared to the year prior. This analysis in addition compare~~d~~s changes in health care utilization among participants with a recent hospitalization to those of a matched cohort of people experiencing homelessness over the same time period who did not receive the intervention.

2. Methods

2.1 Intervention

The Coordinated Access to Care for Homeless adults (CATCH-Homeless) program is a CTI adaptation in Toronto, Canada, supporting adults experiencing homelessness and

mental health needs following discharge from hospital. The program is facilitated through partnerships between three local hospitals serving large numbers of people experiencing homelessness, a primary care team, a homeless shelter, a large community mental health agency, and a physician practice plan. The program accepts referrals from all partner hospital emergency departments (EDs) and inpatient units, or from community agencies, and connects participants with transitional case managers who coordinate access to a full range of post-discharge community-based services, including mental health and addiction services, medical care, peer support, housing assistance, and other resources described in depth elsewhere[33~~29~~].

2.2 Study design

This study is part of a larger mixed-methods evaluation described elsewhere[22~~1~~,33~~29~~]. Using provincial population-based administrative databases at ICES (formerly known as the Institute for Clinical Evaluative Sciences), a single-~~-~~arm pre-post analysis among intervention participants was conducted to evaluate health care utilization outcomes in the year following enrolment in the intervention compared to the year prior. In addition, changes in health service utilization of a subgroup of intervention participants with a recent hospitalization were compared to those of a matched cohort of ~~people~~ adults experiencing

homelessness with at least one psychiatric hospitalization over the same time period who did not receive the intervention.

2.3 Data sources

All administrative health care data were obtained from ICES. ICES is an independent, non-profit research institute funded by an annual grant from the Ontario Ministry of Health (MOH). As a prescribed entity under Ontario's privacy legislation, ICES is authorized to collect and use health care data for the purposes of health system analysis, evaluation and decision support. Secure access to these data is governed by policies and procedures that are approved by the Information and Privacy Commissioner of Ontario. The Ontario Mental Health Reporting System (OMHRS) and the Canadian Institute for Health Information's Discharge Abstract Database (DAD) include data on all psychiatric and acute hospitalizations, respectively. The Ontario Health Insurance Plan (OHIP) claims database contains physician billings data, and the National Ambulatory Care Reporting System gathers data on hospital- and community-based ambulatory care, such as ED visits. The Ontario Registered Persons Database (~~O~~RPDB) is a registry of all individuals living in Ontario who are eligible for public health care insurance and holds data on patient demographics, such as age, sex, and postal code.

2.4 Sample

2.4.1 Intervention participants

Intervention participants were those referred to the intervention by partner sites following discharge from EDs and inpatient units. Intervention eligibility criteria included current homelessness status (defined as living in a crisis/emergency shelter, living on the street, or couch surfing), provider-determined unmet mental health needs, and participant-identified need for support services. Individuals were ineligible for ~~Participants were excluded from the program~~this community-based intervention if they had recent ~~a history of severe aggression or required~~severe aggression or illness severity that required ~~residential~~ institutional care. Study eligibility criteria included being a resident of the province of Ontario, age 18 years and older, and not having previously received services from the program. For the current analysis, 197 individuals, who received the intervention between an index date of January 7, 2013 and May 16, 2014, completed a baseline interview, and agreed to health care record linkage were included. Twenty-six individuals (11.7% of total participants enrolled in the intervention) did not consent to health care record linkage and were excluded from the current analysis. These individuals were not different from consenting individuals in terms of gender but were younger (mean age: 34.9 years vs. 40.3 years; *P*=.021). Furthermore, they were not different in terms of baseline ED visits but had fewer baseline hospitalizations (mean: 0.7 vs. 1.2; *P*=.022). ~~.~~Additional

eExclusion criteria for this analysis included missing patient identifier (required for data linkage), not being enrolled in OHIP, and/or missing data on sex and/or age.

2.4.2 Matched cohort participants

The comparison group , obtained from the ORPD, was composed of individuals aged 18 years and older with recorded homelessness (as identified by a residence variable in the OMHRS or a homelessness variable in the DAD), who had at least one hospitalization for mental health or substance use during the exposure period (index date: January 1, 2013 to May 31, 2014). These individuals were then matched to the intervention participants who had at least one hospitalization in the 12 months prior to their index date. Individuals who received the intervention and who had at least one hospitalization in the 12 months prior to the index date were then matched 1:2 with the comparison group of adults experiencing homelessness who had not received the intervention using propensity score-based matching. Variables used to calculate the propensity score included having a hospitalization in the 12 months prior to the index date, age, sex, neighbourhood income quintile and administrative health region of residence. We selected the closest control that met the following criteria: age within two years at the index date, same sex (hard match) and a propensity score within a caliper width of 0.20. To evaluate matching success, standardized baseline differences were calculated between the subset of intervention

participants and the matched cohort. Standardized differences of 0.10 or less are considered negligible[34]. Individuals were excluded from the matched group if they were ineligible for OHIP and/or had missing sex and/or age data.

2.5 Outcome measures

To evaluate changes in acute health care utilization, count outcomes including the total number of all-cause and mental health and substance use-specific ED visits, hospitalizations, and total hospital days were calculated~~, in addition to~~. D~~d~~ichotomized outcomes indicating whether or not a participant had any all-cause and mental health and substance use-specific ED visits and hospitalizations during the observation period were also calculated. To evaluate changes in outpatient service use, count outcomes including the total number of psychiatrist visits, all-cause and mental health ~~and~~ and ~~addiction~~substance use-specific general practitioner (GP) visits, and the sum total of outpatient visits were calculated, as well as dichotomized outcomes indicating whether or not a participant had any psychiatrist visits and all-cause and mental health ~~and~~ and ~~addiction~~substance use-specific GP visits during the observation period. Diagnostic codes used to determine mental health and ~~addiction~~substance use-specific hospital and outpatient visits are provided in Supplemental Table 1~~4~~.

2.6 Data collection

Intervention participants' demographic and administrative health care records, held by ICES, were linked using unique encoded identifiers; deterministic linkage was applied using OHIP numbers. Health care records were examined for the 12 months pre- and post-index date. The index date for exposure was the intervention enro~~l~~lment date, ranging from January 7, 2013 to May 16, 2014; the study period was January 2012 to May 2015. All participants provided written informed consent and the study received Research Ethics Board approval from Unity Health Toronto. To identify the matched cohort used in comparative analyses, population-based administrative demographic and health records were retrieved and reviewed for the same time periods.

2.7 Statistical analyses

2.7.1 Single arm pre-post analysis

Baseline characteristics for both intervention participants and individuals included in the matched cohort were calculated using frequencies and proportions for categorical variables and means and standard deviation for continuous variables. In the pre-post evaluation, inferential analyses for each count outcome included rates and rate ratios and their respective 95% confidence intervals estimated using generalized estimating equation~~s~~ (GEE) models with a negative binomial distribution and a log link. For each binary outcome, predicted probabilities and prevalence ratios and their respective 95% confidence

intervals were estimated using GEE models with a Poisson distribution and a log link. All models were adjusted for age, sex and neighbourhood income quintile (measured at the Census tract level). An offset variable for person-years was included to adjust for different follow-up lengths.

All analyses were conducted using SAS Enterprise Guide 7.1. A significance level of .05 was used to interpret statistical significance.

~~*2.7.2 Matched cohort selection*~~

~~Individuals who received the intervention and who had at least one hospitalization in the 12 months prior to the index date were matched 1:2 with homeless individuals who had not received the intervention using propensity score-based matching. Variables used to calculate the propensity score included having a hospitalization in the 12 months prior to the index date, age, sex, neighbourhood income quintile and administrative health region of residence. We selected the closest control that met the following criteria: age within two years at the index date, same sex (hard match) and a propensity score within a caliper width of 0.20. To evaluate matching success, standardized baseline differences were calculated between the subset of intervention participants and the matched cohort. Standardized differences of 0.10 or less are considered negligible[30].~~

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2.7.2 Post-hoc comparative analysis

Baseline demographic characteristics were calculated between intervention participants with at least one hospitalization in the 12 months pre-index date and their matched counterparts using frequencies and proportions for categorical variables and means and standard deviation for continuous variables. To show trends between groups and over time, GEE models specifying a negative binomial distribution and a log link were conducted for each count outcome to estimate rate ratios and relative rate ratios; for each binary outcome, GEE models specifying a Poisson distribution and a log link were conducted to calculate prevalence ratios and relative prevalence ratios. All post-hoc models were adjusted for age, sex and neighbourhood income quintiles and included group, time and group by time interaction variables.

3. Results

The cohort selection is detailed in Figure 1. Of the 197 eligible individuals who received the intervention during the study period, 11 health records were unlinkable (six were blank and five were invalid), resulting in a cohort of 186 participants. Of those, 51 individuals were excluded from the matched analysis because they did not have a hospitalization for mental health or substance use in the 12 months prior to the index date required for comparison with the matched sample, leaving a subset of 125 individuals.

Among 3,555 administrative records of ~~homeless individuals~~people experiencing homelessness with a mental health or substance use-specific hospitalization during the exposure period, 250 individuals (1:2 matching) were selected for inclusion in the matched cohort.

3.1 Demographic characteristics

The demographic characteristics of intervention participants (n=186) are presented in Supplemental Table 2~~1~~. The majority of the sample (78.5%) was male. Participants had a mean age of 40.3 years (*SD*=12.0), with an even distribution across age brackets between 18 and 59 years; only 4.3% of participants were over the age of 60.

Table 1 shows the demographic characteristics of the 125 intervention participants included in the matched cohort analysis and their matched counterparts; these were similar to those of the full cohort of intervention participants in age, sex, and neighbourhood income quintile as indicated by no standardized difference between the two groups being greater than 0.10.

3.2 Pre-post analysis

Rates per person-year and rate ratios (RR) for intervention participants (n=186) in the 12 months pre- and post-intervention enrolment for the number of hospital admissions,

hospital days, ED visits and outpatient visits are presented in Table 2; results for binary outcomes are presented in Supplemental Table 3~~2~~. Overall, results reveal changes in health care utilization patterns, with decreased inpatient care and increased outpatient care in the 12 months following enrolment in the intervention, compared to the 12 months prior. Inpatient hospital use decreased significantly among intervention participants in the 12 months following enrolment, especially for mental health and substance use-specific visits. Adjusted admission rates decreased significantly for both all cause and mental health and substance use--specific causes, by 33% (95% CI 15%-47%; *P*=.001) and 43% (95% CI 26%-66%; *P*<.001), respectively, in the 12 months post-intervention relative to 12 months prior. The total number of hospital days also decreased significantly, by 54% (95% CI 36%-77%; *P*<.001) for all-cause days and by 63% (95% CI 48%-74%; *P*<.001) for mental health and substance use days. While the number of ED visits did not change significantly over time, the overall prevalence of ED visits did decrease significantly, by 14% for any reason (95% CI 7%-20%; *P*<.001); and by 31% for mental health and substance use reasons (95% CI 12%-39%; *P*<.001) (Supplemental Table 3~~2~~). In contrast to the decrease in acute hospital service use, outpatient psychiatrist visits increased by 40% (95% CI 1.15-1.70; *P*=.001) in the 12 months following the intervention compared to the 12 months prior; GP visits did not change significantly.

3.3 Matched cohort analysis

Rate ratios and relative rate ratios (RRR) for the subset of intervention participants with at least one hospitalization in the 12 months prior to the index date (n=125) compared to matched controls (n=250) 12 months pre- and post-intervention, for the number of hospital admissions, hospital days, ED visits and outpatient visits are presented in Table 3.~~;~~ P~~p~~revalence ratios (PR) and relative prevalence ratios (RPR) are presented in Supplemental Table 4~~3~~. For both count and binary outcomes, results of the matched cohort analysis suggest that while results generally trended in the same direction as the pre-post analysis, the changes in health service use experienced by intervention participants in the year following receipt of the intervention as compared to the year prior were not significantly different than the changes experienced by their matched counterparts (Table 3).

4. Discussion

Care continuity[35~~31~~] is essential to the delivery of high quality services for people living with chronic health conditions, including mental illness and addictions, and is associated with improved health and service use outcomes[36~~2~~]. Our findings of decreased acute care service use and increased outpatient service use in the 12 months following the intervention as compared to the 12 months prior are consistent with previous outcomes of critical time intervention (CTI) studies, finding significant ~~improvements~~ changes in

outcome measures[24~~3~~,29~~6~~,30~~27~~]. In addition, our findings further support and are supported by previous qualitative research suggesting improved experiences of continuity of care among ~~homeless adults~~adults experiencing homelessness receiving CTI or CTI adaptations[22~~1~~,37~~3~~]. Notably, our findings highlight continued high rates of emergency department (ED) visits post-intervention among participants, suggesting that this population may have more acute and/or enduring needs than the brief CTI adaptation can address in our local context. Access to housing and high quality intensive case management in Toronto, for example, are extremely limited and hindered by long wait lists; it is possible that participants continued to visit the ED for immediate shelter and support post-intervention, as intervention resources were limited and not linked to housing. Persisting high ED use among participants reaffirms the need for inclusion of housing in mental health policy priorities.[17]

Although prior controlled studies of CTI have demonstrated improvements in acute care utilization in some settings[26~~5~~], the addition of a matched cohort analysis in the current study indicates that changes in service use patterns of recipients of a brief CTI adaptation within our setting of universal health insurance and a relatively service-rich environment are not significantly different than those of their matched counterparts.

Similar to this analysis, a prior post-hoc analysis of intervention participants using self-reported data and a comparison group of ~~homeless adults~~ adults experiencing

homelessness ~~with~~ and ~~mental illness~~ mental illness who were receiving usual care found successful reduction in mental health symptoms and alcohol and drug use problems among intervention participants, but increased ED visits and days spent in hospital over six months[24~~43~~]. The current post-hoc analysis, in using administrative data and a cohort matched on prior hospitalizations, ~~adds~~ was intended to build off the limitations of the aforementioned prior analysis[24] by focusing on service use outcomes using administrative data and exploring between-group differences with added methodological ~~additional~~ rigor ~~and identifies no significant difference in service use patterns among intervention and matched cohort participants~~. Additional measures including clinical characteristics such as diagnosis and acuity, and demographic and service use factors such as geographical location and resource availability, may help to better explain the identified non-significant differences between groups in future studies.

Our findings further highlight the need for rigorous methods in evaluating new interventions in diverse contexts. ~~Furthermore, it points to the need to ensure fidelity to key ingredients when adapting evidence-supported interventions in diverse contexts.~~ The brief CTI adaptation evaluated in the current study was set in a large urban centre under a universal health insurance system and included a dedicated, low-barrier, multidisciplinary weekly physician clinic in addition to brief case management support with limited training

and supervision of frontline staff, in keeping with a pragmatic field intervention. Our findings suggest that participants' access to preventative outpatient services ~~use~~ was successfully facilitated by ~~appropriately designed and dedicated~~streamlined access to GPs and psychiatrists. Such an approach may be particularly relevant to similarly large urban centre where timely access to ~~appropriate~~ physician and case management resources is hindered by rapid general and homeless population growth and corresponding demand for services.

While fidelity standards for CTI have been developed, detailing the key model components requiring adherence, and the contextual structures and staff competencies needed to ensure model integrity[38,40,36], a recent systematic review indicates that fidelity and adaptations remain highly variable[26,5] and should be a required component of rigorous evaluations. The fidelity of the intervention to the CTI model was not formally assessed in this study. Future efforts should ensure that local adaptations of evidence-based interventions balance local needs and resources with fidelity to key intervention ingredients, so that evidence generated can be reliably attributed to the model of interest.

4.1 Strengths and limitations

Our findings contribute to the growing evidence on the impact of CTI and its adaptations on health service use. Results are strengthened by the study's methodological

approach, which included the use of population-based administrative data and a rigorous selection process to ensure the appropriateness of comparators. However, the identification of a matched cohort was challenged by the lack of a baseline acuity measure, requiring us to match on recent hospitalizations as a proxy for acuity, although post-matching demographic comparisons suggested the groups were minimally different. Additionally, intervention participants were selected using some clinical criteria that could not be applied to matched individuals identified from administrative data. In the absence of a built-in control group, this an acknowledged design limitation that could have resulted in selection bias.

~~Additionally, we~~We were also limited by our sample size and underpowered to detect hospitalization differences. It is possible that the lower relative rates of psychiatric hospitalizations observed in the intervention group would be significantly different with a larger sample. Still, without a randomized design, it is possible the improvements in health care use observed in the pre-post analysis are due to regression to the mean, rather than the effect of the intervention.

Given the high cost of hospitalizations and from a quality of care perspective, future research should focus on rigorous evaluations using experimental methods with large samples and robust sets of explanatory variables, in addition to approaches to strengthening

fidelity of local adaptations to evidence-supported treatments. Related research should investigate the cost-effectiveness of these interventions to maximize health outcomes given the limited resources available.

5. Conclusions

Study findings suggest that participants of a brief Critical Time Intervention (CTI) for adults experiencing homelessness and unmet mental health needs had decreased acute care use and increased outpatient service use post-intervention. Post-hoc analyses, however, found that changes in service use patterns were not significantly different from those of a matched cohort of adults experiencing homelessness. While ~~Critical Time Intervention~~ CTI and its adaptations hold promise in improving continuity of care and health outcomes ~~among homeless people with mental illness~~for this population, more r~~. R~~igorous study designs with adequate sample sizes~~s~~ are needed to further examine the effectiveness of CTI and local adaptations in diverse health care contexts.

Data Access

Data included in this publication are not publicly available and were collected by ICES. As a prescribed entity under Ontario's privacy legislation, ICES is authorized to collect and use health care data for the purposes of health system analysis, evaluation and decision support. Secure access to these data is governed by policies and procedures that are approved by the Information and Privacy Commissioner of Ontario. For further questions regarding data accessibility, please contact the corresponding author.

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Tables

Table 1: Demographic characteristics of CATCH-H participants *with at least one hospitalization in the 12 months pre-intervention* (n=125) and matched controls (n= 250)

Demographic variables		**CATCH-H participants with hospitalization (n=125)**		**Matched controls (n=250)**		**Standardized difference**
		n	%	n	%	
Age (years)	18 to 29	29	23.2	58	23.2	0
	30 to 39	27	21.6	52	20.8	0.02

	40 to 49	36	28.8	73	29.2	0.01
	50 to 59	25	20	49	19.6	0.01
	60 and over	8	6.4	18	7.2	0.03
	Mean (SD)	41.1 (12.4)		41	12.3	0
Sex	Female	27	21.6	52	20.8	0
	Male	98	78.4	198	79.2	
Neighbourhood income quintile	1* (low)	39	31.2	90	36	0.09
	2 (medium low)	30	24	55	22	0.05
	3 (medium)	26	20.8	49	19.6	0.03
	4 (medium high)	13	10.4	23	9.2	0.04
	5 (high)	17	13.6	33	13.2	0.01

Legend: SD = standard deviation

*1: includes individuals in the 1st income quintile and those where this information was missing

Table 2: Rates per person-year and rate ratios (RR) for CATCH-H participants (n=186) 12 months pre-intervention vs. 12 months post-intervention for number of hospital admissions, hospital days, ED visits and outpatient visits estimated from adjusted generalized estimating equations with negative binomial distribution

Outcome variable			**CATCH-H participants (n=186)**						
			Rate per person-year				Rate ratio (RR)		
			12 months pre-intervention		12 months post-intervention		RR	95% CI	*P*-value
			Rate	95% CI	Rate	95% CI			
Hospital admissions	All cause		2.00	1.54-2.60	1.35	0.96-1.88	**0.67**	0.53-0.85	**.001**
	Mental health and substance use		1.22	0.92-1.63	0.69	0.48-1.01	**0.57**	0.44-0.74	**<.001**
Days in hospital	All cause		24.66	18.93-32.12	11.37	8.09-15.99	**0.46**	0.33-0.64	**<.001**
	Mental health and substance use		17.67	12.34-25.32	6.47	4.22-9.93	**0.37**	0.26-0.52	**<.001**
ED visits	All cause		8.98	6.76-11.94	9.57	6.90-13.29	1.07	0.90-1.25	.446
	Mental health and substance use		3.77	2.79-5.08	3.57	2.49-5.11	0.95	0.75-1.19	.645
Outpatient visits	Psychiatrist		3.16	2.36-4.25	4.42	3.32-5.88	**1.40**	**1.15-1.70**	**.001**
	GP	All cause	7.49	6.30-8.91	7.70	6.63-8.94	1.03	0.88-1.20	.725
		Mental health and substance use	3.38	2.70-4.23	3.80	3.16-4.58	1.13	0.93-1.37	.224
	Total outpatient visits		11.05	9.35-13.07	12.64	10.81-14.77	**1.14**	**1.00-1.31**	**.049**

	(Psychiatrist + GP)									

Legend: CI = confidence interval; GP = general practitioner

Table 3: Rate ratios (RR) and relative rate ratios (RRR) for *CATCH-H participants with at least one hospitalization in the 12 months pre-intervention* (n=125) compared to matched controls (n=250) 12 months pre-intervention vs. 12 months post-intervention for number of hospital admissions, hospital days, ED visits and outpatient visits estimated using adjusted generalized estimating equations with negative binomial distribution

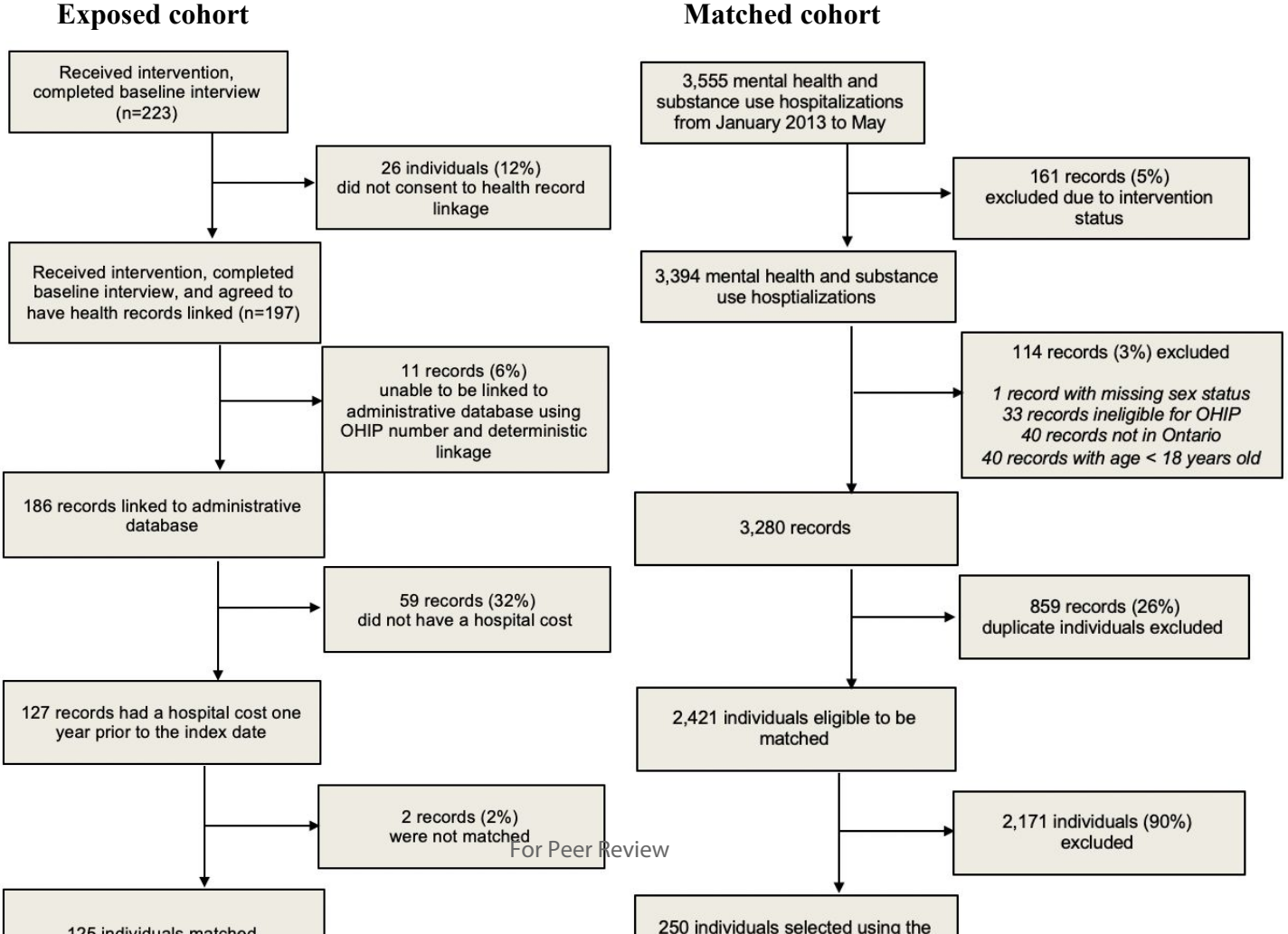
Outcome variable		**12 months pre-intervention**			**12 months post-intervention**			**Relative rate ratio (RRR) 12 months post-intervention vs. 12 months pre-intervention**		
		RR	95% CI	*P*-value	RR	95% CI	*P*-value	RRR	95% CI	*P*-value
Hospital admissions	All cause	1.20	0.99 - 1.45	.057	1.17	0.82- 1.66	.38	0.97	0.71- 1.33	.870
	Mental health and substance use	1.06	0.87 - 1.29	.565	0.95	0.64- 1.39	.78	0.89	0.63- 1.26	.522
Days in hospital	All cause	1.04	0.75 - 1.43	.808	0.77	0.51- 1.17	.22	0.74	0.46- 1.20	.225
	Mental health and substance use	0.93	0.67 - 1.29	.667	**0.60**	**0.38- 0.95**	**.03**	0.64	0.38- 1.10	.104
ED visits	All cause	**1.35**	**1.01 - 1.79**	**.040**	**1.69**	**1.19- 2.42**	**.004**	1.26	0.95- 1.67	.113

		Mental health and substance use	1.33	0.95 - 1.86	.096	**1.64**	**1.11- 2.43**	**.01**	1.23	0.89- 1.71	.212
Outpatient visits		Psychiatrist	1.29	0.96 - 1.74	.091	**1.34**	**1.02- 1.77**	**.04**	1.04	0.77- 1.40	.806
	GP	All cause	1.22	0.96 - 1.56	.102	**1.36**	**1.06- 1.75**	**.02**	1.11	0.86- 1.44	.409
		Mental health and substance use	1.16	0.85 - 1.58	.356	1.32	0.98- 1.77	.07	1.14	0.84- 1.55	.408
		Total outpatient visits (Psychiatrist + GP)	**1.24**	**1.02 - 1.52**	**.035**	**1.33**	**1.10- 1.62**	**.003**	1.07	0.87- 1.33	.522

Legend: CI = confidence interval; GP = general practitioner

Figures

Figure 1. Exposed and matched cohort selection



For Peer Review

Title

Evaluating the impact of a Critical Time Intervention adaptation on health care utilization among homeless adults with mental health needs in a large urban centre

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Abstract

Objective: This study evaluated the impact of a Critical Time Intervention (CTI) adaptation on health care utilization outcomes among adults experiencing homelessness and mental health needs in a large urban centre.

Method: Provincial population-based administrative data from Ontario, Canada were used in a pre-post design for a cohort of 197 individuals who received the intervention between January 2013 and May 2014 and were matched to a cohort of adults experiencing homelessness who did not receive the intervention over the same time period. Changes in health care utilization outcomes in the year pre- and post-intervention were evaluated using generalized estimating equations and post-hoc analyses evaluated differences between groups.

Results: Pre-post analyses revealed statistically significant changes in health care utilization patterns among intervention recipients, including reduced inpatient service use and increased outpatient service use in the year following the intervention compared to the year prior. However, the matched cohort analysis found non-significant differences in health service use changes between a subgroup of intervention recipients and their matched counterparts.

Conclusions: An adapted CTI model was associated with changes in health care utilization among people experiencing homelessness and mental health needs. However, changes were not different from those observed in a matched cohort. Rigorous study designs with adequate samples are needed to examine the effectiveness of CTI and local adaptations in diverse health care contexts.

Keywords: Critical Time Intervention, case management, homeless, mental health services, addiction, health care utilization

1. Introduction

Internationally, rates of homelessness continue to rise[1,2]; and in Canada, national data show an increase in demand for shelter beds over time, with at least 235,000 Canadians experiencing homelessness in a year[3]. People experiencing homelessness also experience higher rates of mental health and addiction challenges[4], neurocognitive impairment[5,6], physical health problems and premature mortality[7,8], compared to their housed counterparts. Despite the health disparities, this population generally has limited access to appropriate, high quality health care and supports, even in settings with universal health insurance[9-12]. Together, these factors contribute to high rates of hospital service use and costs[13-16].

Given increasing rates of homelessness and the impact of homelessness on health[17], there is an urgent need for interventions to improve health outcomes in this population, including avoidable hospital service utilization[15]. For adults experiencing mental illness, care following discharge from hospital for a mental health condition is reportedly the most important factor in reducing reliance on subsequent inpatient care[18]. Adults experiencing mental illness and homelessness, however, are less likely to be referred to and access community-based services upon discharge from hospital, compared to housed individuals[19,20].

Among people experiencing homelessness, strategies to improve continuity of care by offering intensive time-limited services to support the transition from hospital to community-based services have shown promising findings[21-26]. Critical time intervention (CTI) was designed to support homeless individuals during transitions of care, including the period post-hospital discharge in which people experiencing mental illness are at high risk of experiencing first-episode or recurrent homelessness.[27,28] Critical time interventions involve time-limited intensive case management over a period of six to nine months and aim to help service users navigate the complex service system and establish (or re-establish) access to longer-term community-based connections, resources and interventions. This particular model has been shown to decrease early psychiatric readmission rates[24,29,30], improve perceived quality of care[22,25], improve health and quality of life outcomes[24,30], and reduce rates of homelessness[27,31.] Past evaluations of CTIs have also suggested that this approach is cost-effective[32] in supporting transitions of care.

More evidence of the impact of CTI models, and their adaptations in diverse settings, is urgently needed to support implementation of effective and cost-effective strategies to improve health and housing outcomes among people experiencing homelessness and who have unmet mental health needs. A recent pre-post evaluation of a CTI adaptation for adults experiencing homelessness and mental health needs who were

transitioning from hospital to community services in Toronto, Canada, reported significant improvements in mental and physical health, substance use, and quality of life in the six months following the intervention[24]. Expanding on this work, the primary objective of this study was to use administrative health care utilization data to evaluate whether a brief CTI adaptation for adults experiencing homelessness and mental health needs who were discharged from hospital services was associated with significant changes in health care utilization outcomes in the year post-intervention compared to the year prior. This analysis in addition compared changes in health care utilization among participants with a recent hospitalization to those of a matched cohort of people experiencing homelessness over the same time period who did not receive the intervention.

2. Methods

2.1 Intervention

The Coordinated Access to Care for Homeless adults (CATCH-Homeless) program is a CTI adaptation in Toronto, Canada, supporting adults experiencing homelessness and mental health needs following discharge from hospital. The program is facilitated through partnerships between three local hospitals serving large numbers of people experiencing homelessness, a primary care team, a homeless shelter, a large community mental health agency, and a physician practice plan. The program accepts referrals from all partner

hospital emergency departments (EDs) and inpatient units, or from community agencies, and connects participants with transitional case managers who coordinate access to a full range of post-discharge community-based services, including mental health and addiction services, medical care, peer support, housing assistance, and other resources described in depth elsewhere[33].

2.2 Study design

This study is part of a larger mixed-methods evaluation described elsewhere[22,33]. Using provincial population-based administrative databases at ICES (formerly known as the Institute for Clinical Evaluative Sciences), a single-arm pre-post analysis among intervention participants was conducted to evaluate health care utilization outcomes in the year following enrolment in the intervention compared to the year prior. In addition, changes in health service utilization of a subgroup of intervention participants with a recent hospitalization were compared to those of a matched cohort of adults experiencing homelessness with at least one psychiatric hospitalization over the same time period who did not receive the intervention.

2.3 Data sources

All administrative health care data were obtained from ICES. ICES is an independent, non-profit research institute funded by an annual grant from the Ontario Ministry of Health (MOH). As a prescribed entity under Ontario's privacy legislation, ICES is authorized to collect and use health care data for the purposes of health system analysis, evaluation and decision support. Secure access to these data is governed by policies and procedures that are approved by the Information and Privacy Commissioner of Ontario. The Ontario Mental Health Reporting System (OMHRS) and the Canadian Institute for Health Information's Discharge Abstract Database (DAD) include data on all psychiatric and acute hospitalizations, respectively. The Ontario Health Insurance Plan (OHIP) claims database contains physician billings data, and the National Ambulatory Care Reporting System gathers data on hospital- and community-based ambulatory care, such as ED visits. The Ontario Registered Persons Database (RPDB) is a registry of all individuals living in Ontario who are eligible for public health care insurance and holds data on patient demographics, such as age, sex, and postal code.

2.4 Sample

2.4.1 Intervention participants

Intervention participants were those referred to the intervention by partner sites following discharge from EDs and inpatient units. Intervention eligibility criteria included

current homelessness status (defined as living in a crisis/emergency shelter, living on the street, or couch surfing), provider-determined unmet mental health needs, and participant-identified need for support services. Individuals were ineligible for this community-based intervention if they had recent severe aggression or illness severity that required institutional care. Study eligibility criteria included being a resident of the province of Ontario, age 18 years and older, and not having previously received services from the program. For the current analysis, 197 individuals, who received the intervention between an index date of January 7, 2013 and May 16, 2014, completed a baseline interview, and agreed to health care record linkage were included. Twenty-six individuals (11.7% of total participants enrolled in the intervention) did not consent to health care record linkage and were excluded from the current analysis. These individuals were not different from consenting individuals in terms of gender but were younger (mean age: 34.9 years vs. 40.3 years; P=.021). Furthermore, they were not different in terms of baseline ED visits but had fewer baseline hospitalizations (mean: 0.7 vs. 1.2; P=.022). Additional exclusion criteria for this analysis included missing patient identifier (required for data linkage), not being enrolled in OHIP, and/or missing data on sex and/or age.

2.4.2 Matched cohort participants

The comparison group was composed of individuals aged 18 years and older with recorded homelessness (as identified by a residence variable in the OMHRS or a homelessness variable in the DAD), who had at least one hospitalization for mental health or substance use during the exposure period (index date: January 1, 2013 to May 31, 2014). Individuals who received the intervention and who had at least one hospitalization in the 12 months prior to the index date were then matched 1:2 with the comparison group of adults experiencing homelessness who had not received the intervention using propensity score-based matching. Variables used to calculate the propensity score included having a hospitalization in the 12 months prior to the index date, age, sex, neighbourhood income quintile and administrative health region of residence. We selected the closest control that met the following criteria: age within two years at the index date, same sex (hard match) and a propensity score within a caliper width of 0.20. To evaluate matching success, standardized baseline differences were calculated between the subset of intervention participants and the matched cohort. Standardized differences of 0.10 or less are considered negligible[34]. Individuals were excluded from the matched group if they were ineligible for OHIP and/or had missing sex and/or age data.

2.5 Outcome measures

To evaluate changes in acute health care utilization, count outcomes including the total number of all-cause and mental health and substance use-specific ED visits, hospitalizations, and total hospital days were calculated. Dichotomized outcomes indicating whether or not a participant had any all-cause and mental health and substance use-specific ED visits and hospitalizations during the observation period were also calculated. To evaluate changes in outpatient service use, count outcomes including the total number of psychiatrist visits, all-cause and mental health and substance use-specific general practitioner (GP) visits, and the sum total of outpatient visits were calculated, as well as dichotomized outcomes indicating whether or not a participant had any psychiatrist visits and all-cause and mental health and substance use-specific GP visits during the observation period. Diagnostic codes used to determine mental health and substance use-specific hospital and outpatient visits are provided in Supplemental Table 1.

2.6 Data collection

Intervention participants' demographic and administrative health care records, held by ICES, were linked using unique encoded identifiers*;* deterministic linkage was applied using OHIP numbers. Health care records were examined for the 12 months pre- and post-index date. The index date for exposure was the intervention enrolment date, ranging from January 7, 2013 to May 16, 2014; the study period was January 2012 to May 2015. All

participants provided written informed consent and the study received Research Ethics Board approval from Unity Health Toronto. To identify the matched cohort used in comparative analyses, population-based administrative demographic and health records were retrieved and reviewed for the same time periods.

2.7 Statistical analyses

2.7.1 Single arm pre-post analysis

Baseline characteristics for both intervention participants and individuals included in the matched cohort were calculated using frequencies and proportions for categorical variables and means and standard deviation for continuous variables. In the pre-post evaluation, inferential analyses for each count outcome included rates and rate ratios and their respective 95% confidence intervals estimated using generalized estimating equation (GEE) models with a negative binomial distribution and a log link. For each binary outcome, predicted probabilities and prevalence ratios and their respective 95% confidence intervals were estimated using GEE models with a Poisson distribution and a log link. All models were adjusted for age, sex and neighbourhood income quintile (measured at the Census tract level). An offset variable for person-years was included to adjust for different follow-up lengths.

All analyses were conducted using SAS Enterprise Guide 7.1. A significance level of .05 was used to interpret statistical significance.

2.7.2 Post-hoc comparative analysis

Baseline demographic characteristics were calculated between intervention participants with at least one hospitalization in the 12 months pre-index date and their matched counterparts using frequencies and proportions for categorical variables and means and standard deviation for continuous variables. To show trends between groups and over time, GEE models specifying a negative binomial distribution and a log link were conducted for each count outcome to estimate rate ratios and relative rate ratios; for each binary outcome, GEE models specifying a Poisson distribution and a log link were conducted to calculate prevalence ratios and relative prevalence ratios. All post-hoc models were adjusted for age, sex and neighbourhood income quintiles and included group, time and group by time interaction variables.

3. Results

The cohort selection is detailed in Figure 1. Of the 197 eligible individuals who received the intervention during the study period, 11 health records were unlinkable (six were blank and five were invalid), resulting in a cohort of 186 participants. Of those, 51

individuals were excluded from the matched analysis because they did not have a hospitalization for mental health or substance use in the 12 months prior to the index date required for comparison with the matched sample, leaving a subset of 125 individuals. Among 3,555 administrative records of people experiencing homelessness with a mental health or substance use-specific hospitalization during the exposure period, 250 individuals (1:2 matching) were selected for inclusion in the matched cohort.

3.1 Demographic characteristics

The demographic characteristics of intervention participants (n=186) are presented in Supplemental Table 2. The majority of the sample (78.5%) was male. Participants had a mean age of 40.3 years (*SD*=12.0), with an even distribution across age brackets between 18 and 59 years; only 4.3% of participants were over the age of 60.

Table 1 shows the demographic characteristics of the 125 intervention participants included in the matched cohort analysis and their matched counterparts; these were similar to those of the full cohort of intervention participants in age, sex, and neighbourhood income quintile as indicated by no standardized difference between the two groups being greater than 0.10.

3.2 Pre-post analysis

Rates per person-year and rate ratios (RR) for intervention participants (n=186) in the 12 months pre- and post-intervention enrolment for the number of hospital admissions, hospital days, ED visits and outpatient visits are presented in Table 2; results for binary outcomes are presented in Supplemental Table 3. Overall, results reveal changes in health care utilization patterns, with decreased inpatient care and increased outpatient care in the 12 months following enrolment in the intervention, compared to the 12 months prior. Inpatient hospital use decreased significantly among intervention participants in the 12 months following enrolment, especially for mental health and substance use-specific visits. Adjusted admission rates decreased significantly for both all cause and mental health and substance use-specific causes, by 33% (95% CI 15%-47%; *P*=.001) and 43% (95% CI 26%-66%; *P*<.001), respectively, in the 12 months post-intervention relative to 12 months prior. The total number of hospital days also decreased significantly, by 54% (95% CI 36%-77%; *P*<.001) for all-cause days and by 63% (95% CI 48%-74%; *P*<.001) for mental health and substance use days. While the number of ED visits did not change significantly over time, the overall prevalence of ED visits did decrease significantly, by 14% for any reason (95% CI 7%-20%; *P*<.001); and by 31% for mental health and substance use reasons (95% CI 12%-39%; *P*<.001) (Supplemental Table 3). In contrast to the decrease in acute hospital service use, outpatient psychiatrist visits increased by 40% (95% CI 1.15-

1.70; *P*=.001) in the 12 months following the intervention compared to the 12 months prior; GP visits did not change significantly.

3.3 Matched cohort analysis

Rate ratios and relative rate ratios (RRR) for the subset of intervention participants with at least one hospitalization in the 12 months prior to the index date (n=125) compared to matched controls (n=250) 12 months pre- and post-intervention, for the number of hospital admissions, hospital days, ED visits and outpatient visits are presented in Table 3. Prevalence ratios (PR) and relative prevalence ratios (RPR) are presented in Supplemental Table 4. For both count and binary outcomes, results of the matched cohort analysis suggest that while results generally trended in the same direction as the pre-post analysis, the changes in health service use experienced by intervention participants in the year following receipt of the intervention as compared to the year prior were not significantly different than the changes experienced by their matched counterparts (Table 3).

4. Discussion

Care continuity[35] is essential to the delivery of high quality services for people living with chronic health conditions, including mental illness and addictions, and is associated with improved health and service use outcomes[36]. Our findings of decreased

acute care service use and increased outpatient service use in the 12 months following the intervention as compared to the 12 months prior are consistent with previous outcomes of critical time intervention (CTI) studies, finding significant changes in outcome measures[24,29,30]. In addition, our findings further support and are supported by previous qualitative research suggesting improved experiences of continuity of care among adults experiencing homelessness receiving CTI or CTI adaptations[22,37]. Notably, our findings highlight continued high rates of emergency department (ED) visits post-intervention among participants, suggesting that this population may have more acute and/or enduring needs than the brief CTI adaptation can address in our local context. Access to housing and high quality intensive case management in Toronto, for example, are extremely limited and hindered by long wait lists; it is possible that participants continued to visit the ED for immediate shelter and support post-intervention, as intervention resources were limited and not linked to housing. Persisting high ED use among participants reaffirms the need for inclusion of housing in mental health policy priorities.[17]

Although prior controlled studies of CTI have demonstrated improvements in acute care utilization in some settings[26], the addition of a matched cohort analysis in the current study indicates that changes in service use patterns of recipients of a brief CTI adaptation within our setting of universal health insurance and a relatively service-rich environment

are not significantly different than those of their matched counterparts. Similar to this analysis, a prior post-hoc analysis of intervention participants using self-reported data and a comparison group of adults experiencing homelessness and mental illness who were receiving usual care found successful reduction in mental health symptoms and alcohol and drug use problems among intervention participants, but increased ED visits and days spent in hospital over six months[24]. The current post-hoc analysis, in using administrative data and a cohort matched on prior hospitalizations, was intended to build off the limitations of the aforementioned prior analysis[24] by focusing on service use outcomes using administrative data and exploring between-group differences with added methodological rigor. Additional measures including clinical characteristics such as diagnosis and acuity, and demographic and service use factors such as geographical location and resource availability, may help to better explain the identified non-significant differences between groups in future studies.

Our findings further highlight the need for rigorous methods in evaluating new interventions in diverse contexts. The brief CTI adaptation evaluated in the current study was set in a large urban centre under a universal health insurance system and included a dedicated, low-barrier, multidisciplinary weekly physician clinic in addition to brief case management support with limited training and supervision of frontline staff, in keeping

with a pragmatic field intervention. Our findings suggest that participants' access to preventative outpatient services was successfully facilitated by streamlined access to GPs and psychiatrists. Such an approach may be particularly relevant to similarly large urban centre where timely access to physician and case management resources is hindered by rapid general and homeless population growth and corresponding demand for services. While fidelity standards for CTI have been developed, detailing the key model components requiring adherence, and the contextual structures and staff competencies needed to ensure model integrity[38-40], a recent systematic review indicates that fidelity and adaptations remain highly variable[26] and should be a required component of rigorous evaluations. The fidelity of the intervention to the CTI model was not formally assessed in this study. Future efforts should ensure that local adaptations of evidence-based interventions balance local needs and resources with fidelity to key intervention ingredients, so that evidence generated can be reliably attributed to the model of interest.

4.1 Strengths and limitations

Our findings contribute to the growing evidence on the impact of CTI and its adaptations on health service use. Results are strengthened by the study's methodological approach, which included the use of population-based administrative data and a rigorous selection process to ensure the appropriateness of comparators. However, the identification

of a matched cohort was challenged by the lack of a baseline acuity measure, requiring us to match on recent hospitalizations as a proxy for acuity, although post-matching demographic comparisons suggested the groups were minimally different. Additionally, intervention participants were selected using some clinical criteria that could not be applied to matched individuals identified from administrative data. In the absence of a built-in control group, this an acknowledged design limitation that could have resulted in selection bias.

We were also limited by our sample size and underpowered to detect hospitalization differences. It is possible that the lower relative rates of psychiatric hospitalizations observed in the intervention group would be significantly different with a larger sample. Still, without a randomized design, it is possible the improvements in health care use observed in the pre-post analysis are due to regression to the mean, rather than the effect of the intervention.

Given the high cost of hospitalizations and from a quality of care perspective, future research should focus on rigorous evaluations using experimental methods with large samples and robust sets of explanatory variables, in addition to approaches to strengthening fidelity of local adaptations to evidence-supported treatments. Related research should

investigate the cost-effectiveness of these interventions to maximize health outcomes given the limited resources available.

5. Conclusions

Study findings suggest that participants of a brief Critical Time Intervention (CTI) for adults experiencing homelessness and unmet mental health needs had decreased acute care use and increased outpatient service use post-intervention. Post-hoc analyses, however, found that changes in service use patterns were not significantly different from those of a matched cohort of adults experiencing homelessness. While CTI and its adaptations hold promise in improving continuity of care and health outcomes for this population, more rigorous study designs with adequate sample sizes are needed to further examine the effectiveness of CTI and local adaptations in diverse health care contexts.

Data Access

Data included in this publication are not publicly available and were collected by ICES. As a prescribed entity under Ontario's privacy legislation, ICES is authorized to collect and use health care data for the purposes of health system analysis, evaluation and decision support. Secure access to these data is governed by policies and procedures that are approved by the Information and Privacy Commissioner of Ontario. For further questions regarding data accessibility, please contact the corresponding author.

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Conflict of Interest Disclosure: none.

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Tables

Table 1: Demographic characteristics of CATCH-H participants *with at least one hospitalization in the 12 monthspre-intervention* (n=125) and matched controls (n= 250)

Demographic variables		**CATCH-H participants with hospitalization (n=125)**		**Matched controls (n=250)**		**Standardized difference**
		n	%	n	%	
Age (years)	18 to 29	29	23.2	58	23.2	0
	30 to 39	27	21.6	52	20.8	0.02
	40 to 49	36	28.8	73	29.2	0.01
	50 to 59	25	20	49	19.6	0.01
	60 and over	8	6.4	18	7.2	0.03
	Mean (SD)	41.1 (12.4)		41	12.3	0
Sex	Female	27	21.6	52	20.8	0
	Male	98	78.4	198	79.2	
Neighbourhood income quintile	1* (low)	39	31.2	90	36	0.09
	2 (medium low)	30	24	55	22	0.05
	3 (medium)	26	20.8	49	19.6	0.03
	4 (medium high)	13	10.4	23	9.2	0.04
	5 (high)	17	13.6	33	13.2	0.01

Legend: SD = standard deviation

*1: includes individuals in the 1st income quintile and those where this information was missing

Table 2: Rates per person-year and rate ratios (RR) for CATCH-H participants (n=186) 12 months pre-intervention vs. 12 months post-intervention for number of hospital admissions, hospital days, ED visits and outpatient visits estimated from adjusted generalized estimating equations with negative binomial distribution

Outcome variable			**CATCH-H participants (n=186)**						
			Rate per person-year				Rate ratio (RR)		
			12 months pre-intervention		12 months post-intervention		RR	95% CI	*P*-value
			Rate	95% CI	Rate	95% CI			
Hospital admissions	All cause		2.00	1.54-2.60	1.35	0.96-1.88	**0.67**	0.53-0.85	**.001**
	Mental health and substance use		1.22	0.92-1.63	0.69	0.48-1.01	**0.57**	0.44-0.74	**<.001**
Days in hospital	All cause		24.66	18.93-32.12	11.37	8.09-15.99	**0.46**	0.33-0.64	**<.001**
	Mental health and substance use		17.67	12.34-25.32	6.47	4.22-9.93	**0.37**	0.26-0.52	**<.001**
ED visits	All cause		8.98	6.76-11.94	9.57	6.90-13.29	1.07	0.90-1.25	.446
	Mental health and substance use		3.77	2.79-5.08	3.57	2.49-5.11	0.95	0.75-1.19	.645
Outpatient visits	Psychiatrist		3.16	2.36-4.25	4.42	3.32-5.88	**1.40**	**1.15-1.70**	**.001**
	GP	All cause	7.49	6.30-8.91	7.70	6.63-8.94	1.03	0.88-1.20	.725
		Mental health and substance use	3.38	2.70-4.23	3.80	3.16-4.58	1.13	0.93-1.37	.224
	Total outpatient visits		11.05	9.35-13.07	12.64	10.81-14.77	**1.14**	**1.00-1.31**	**.049**

	(Psychiatrist + GP)									

Legend: CI = confidence interval; GP = general practitioner

Table 3: Rate ratios (RR) and relative rate ratios (RRR) for *CATCH-H participants with at least one hospitalization in the 12 months pre-intervention* (n=125) compared to matched controls (n=250) 12 months pre-intervention vs. 12 months post-intervention for number of hospital admissions, hospital days, ED visits and outpatient visits estimated using adjusted generalized estimating equations with negative binomial distribution

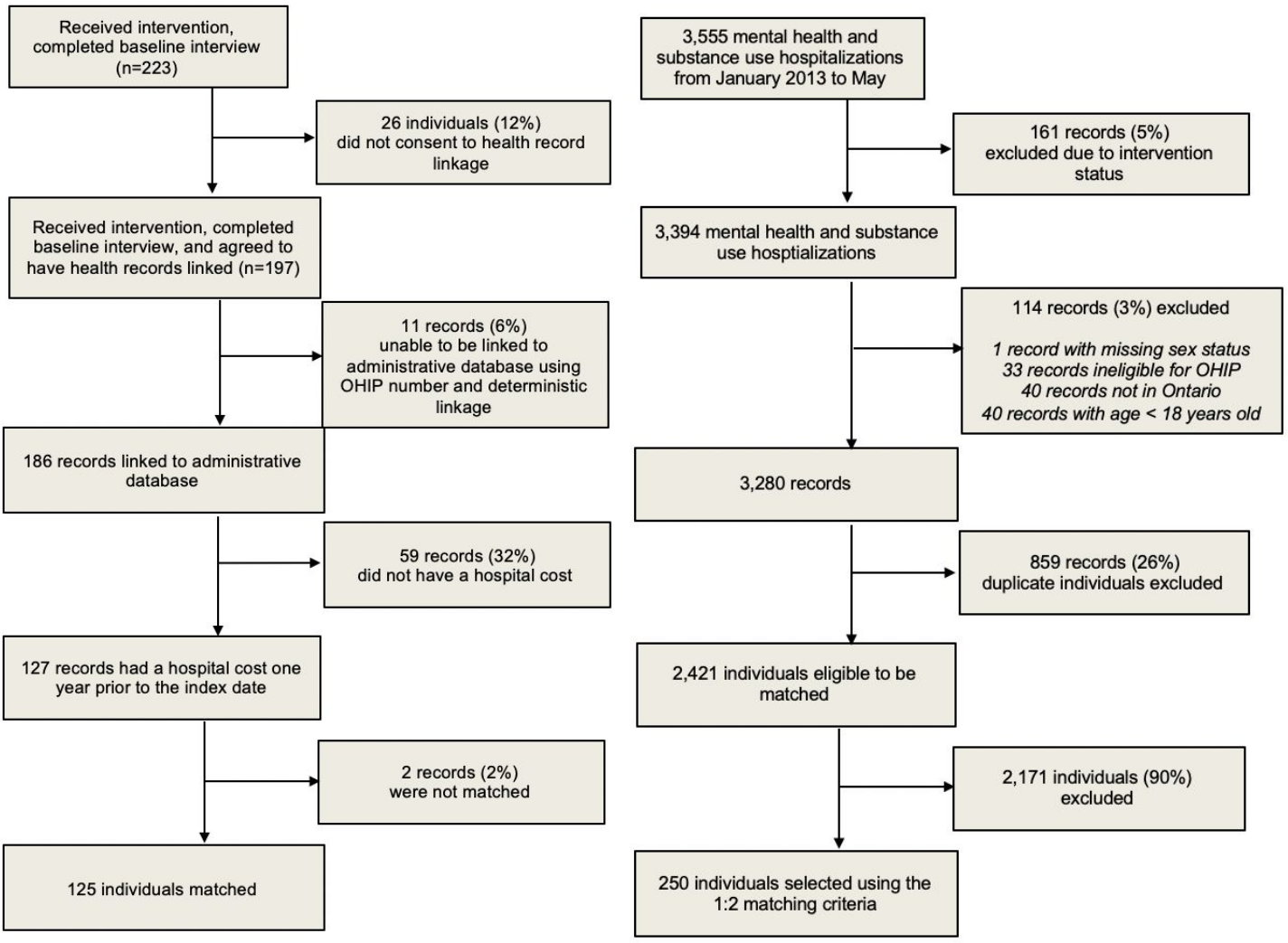
Outcome variable		**12 months pre-intervention**			**12 months post-intervention**			**Relative rate ratio (RRR) 12 months post-intervention vs. 12 months pre-intervention**		
		RR	95% CI	*P*-value	RR	95% CI	*P*-value	RRR	95% CI	*P*-value
Hospital admissions	All cause	1.20	0.99-1.45	.057	1.17	0.82-1.66	.38	0.97	0.71-1.33	.870
	Mental health and substance use	1.06	0.87-1.29	.565	0.95	0.64-1.39	.78	0.89	0.63-1.26	.522
Days in hospital	All cause	1.04	0.75-1.43	.808	0.77	0.51-1.17	.22	0.74	0.46-1.20	.225
	Mental health and substance use	0.93	0.67-1.29	.667	**0.60**	**0.38-0.95**	**.03**	0.64	0.38-1.10	.104
ED visits	All cause	**1.35**	**1.01-1.79**	**.040**	**1.69**	**1.19-2.42**	**.004**	1.26	0.95-1.67	.113

	Mental health and substance use	1.33	0.95 - 1.86	.096	**1.64**	**1.11- 2.43**	**.01**	1.23	0.89- 1.71	.212
Outpatient visits	Psychiatrist	1.29	0.96 - 1.74	.091	**1.34**	**1.02- 1.77**	**.04**	1.04	0.77- 1.40	.806
	GP All cause	1.22	0.96 - 1.56	.102	**1.36**	**1.06- 1.75**	**.02**	1.11	0.86- 1.44	.409
	GP Mental health and substance use	1.16	0.85 - 1.58	.356	1.32	0.98- 1.77	.07	1.14	0.84- 1.55	.408
	Total outpatient visits (Psychiatrist + GP)	**1.24**	**1.02 - 1.52**	**.035**	**1.33**	**1.10- 1.62**	**.003**	1.07	0.87- 1.33	.522

Legend: CI = confidence interval; GP = general practitioner

Figures

Figure 1. Exposed and matched cohort selection



Supplementary Materials

Supplemental Table 1: Diagnostic codes used in cohort selection

Mental health outcomes	**Diagnostic Codes**
Hospitalizations	ICD-10-CA: all F codes (main diagnosis) OMHRS: all discharges
Emergency department visits	ICD-10-CA: F04 to F99 (main diagnosis) ICD-10-CA: X60-X84, Y10-Y19, Y28 (any diagnosis)
Psychiatrist visits	OHIP visit/consult to a psychiatrist [SPEC = 19]
General practitioner outpatient visits	OHIP visit/consult to a general practitioner [SPEC = 00] AND a mental health diagnostic code:295, 296, 297, 298, 300, 301, 302, 306, 309, 311, 303, 304, 897, 898, 899, 900, 901, 902, 904, 905, 906,909

Supplemental Table 2: Demographics of CATCH-H cohort (n=186)

Demographic variables		**N**	**%**
Age (years)	18 to 29	43	23.1
	30 to 39	46	24.7
	40 to 49	51	27.4
	50 to 59	38	20.4
	60 and over	8	4.3
	Mean (SD)		40.3 (12.0)
Sex	Female	40	21.5
	Male	146	78.5
Neighbourhood income quintile	Missing	6	3.2
	1 (low)	56	30.1
	2 (medium low)	44	23.7
	3 (medium)	41	22.0
	4 (medium high)	16	8.6
	5 (high)	23	12.4

Legend: SD = standard deviation

Supplemental Table 3: Predicted probabilities and prevalence ratios (PR) for CATCH-H participants (n=186) 12 months pre-intervention vs. 12 months post-intervention for any hospital admission, any ED visit, and any outpatient visit estimated from adjusted generalized estimating equations with Poisson distribution

Outcome variable			**CATCH-H participants (n=186)**						
			Predicted probability (PP)				Prevalence ratio (PR)		
			12 months pre-intervention		12 months post-intervention		PR	95% CI	*P*-value
			PP	95% CI	PP	95% CI			
Any hospital admission	All cause		0.77	0.68-0.86	0.48	0.40-0.57	**0.62**	0.52-0.74	**<.001**
	Mental health		0.58	0.46-0.73	0.31	0.24-0.41	**0.54**	0.44-0.67	**<.001**
Any ED visit	All cause		0.96	0.91-1.01	0.83	0.77-0.89	**0.86**	0.80-0.93	**<.001**
	Mental health		0.79	0.71-0.87	0.54	0.47-0.63	**0.69**	0.61-0.78	**<.001**
Any outpatient visit	Psychiatrist		0.74	0.65-0.85	0.69	0.60-0.79	0.93	0.84-1.03	.174
	GP	All cause	0.86	0.80-0.93	0.89	0.83-0.95	1.03	0.96-1.10	.392
		Mental health	0.73	0.65-0.80	0.76	0.68-0.84	1.04	0.94-1.16	.449
	Total outpatient visits (Psychiatrist + GP)		0.95	0.92-0.99	0.98	0.95-1.01	1.03	0.98-1.07	.231

Legend: CI = confidence interval; GP = general practitioner

Supplemental Table 4: Prevalence ratios (PR) and relative prevalence ratios (RPR) for *CATCH-H participants with at least one hospitalization in the 12 months pre-intervention* (n=125) compared to matched controls (n=250) 12 months pre-intervention vs. 12 months post-intervention for any hospital admission, ED visit and outpatient visit estimated using adjusted generalized estimating equations with Poisson distribution

Outcome variable			**12 months pre-intervention**			**12 months post-intervention**			**Relative prevalence ratio (RPR) 12 months post-intervention vs. 12 months pre-intervention**		
			PR	95% CI	*P*-value	PR	95% CI	*P*-value	RPR	95% CI	*P*-value
Any hospital admission	All cause		1.00	0.99-1.01	.982	0.89	0.72-1.10	.30	0.89	0.72-1.10	.297
	Mental health		**0.86**	**0.80-0.92**	**<.001**	**0.78**	**0.60-1.00**	**.047**	0.91	0.71-1.17	.450
Any ED visit	All cause		1.03	0.99-1.06	.142	1.07	0.96-1.20	.20	1.05	0.94-1.17	.428
	Mental health		0.97	0.89-1.05	.456	0.91	0.75-1.11	.36	0.94	0.78-1.14	.546
Any outpatient visit	Psychiatrist		**1.13**	**1.01-1.26**	**.040**	1.09	0.96-1.25	.18	0.97	0.83-1.14	.728
	GP	All cause	1.08	0.98-1.19	.120	**1.16**	**1.06-1.27**	**.002**	1.07	0.96-1.20	.239
		Mental health	1.14	0.99-1.32	.066	**1.26**	**1.10-1.45**	**.001**	1.10	0.93-1.31	.259
	Total outpatient visits (Psychiatrist + GP)		1.03	0.97-1.09	.368	1.03	0.98-1.09	.24	1.01	0.93-1.08	.890

Legend: CI = confidence interval; GP = general practitioner

Évaluer l'effet d'une adaptation de l'intervention en temps critique sur l'utilisation des soins de santé chez des adultes itinérants ayant des besoins de santé mentale dans un grand centre urbain

Objectif : La présente étude a évalué l'effet d'une adaptation de l'intervention en temps critique (ITC) sur les résultats de l'utilisation des soins de santé chez des adultes en situation d'itinérance et ayant des besoins de santé mentale dans un grand centre urbain.

Méthode : Des données administratives provinciales dans la population de l'Ontario, Canada, ont servi à une méthode avant et après pour une cohorte de 197 personnes qui ont reçu l'intervention entre janvier 2013 et mai 2014, et ont été appariées à une cohorte d'adultes en situation d'itinérance qui n'ont pas reçu l'intervention durant la même période. Les changements des résultats de l'utilisation des soins de santé dans l'année avant et après l'intervention ont été évalués à l'aide d'équations d'estimation généralisées et des analyses a posteriori ont évalué les différences entre les groupes.

Résultats : Les analyses avant et après ont révélé des changements statistiquement significatifs des modèles d'utilisation des soins de santé chez les bénéficiaires de l'intervention, notamment une utilisation réduite des services pour les patients hospitalisés et une utilisation accrue des services pour les patients ambulatoires dans l'année suivant l'intervention comparé à l'année précédente. Toutefois, l'analyse de la cohorte appariée a constaté des différences non significatives dans les changements d'utilisation des services de santé entre un sous-groupe de bénéficiaires de l'intervention et leurs homologues appariés.

Conclusions : Un modèle adapté d'ITC était associé à des changements de l'utilisation des soins de santé chez les personnes en situation d'itinérance et ayant des besoins de santé mentale. Cependant, les changements n'étaient pas différents de ceux observés dans une cohorte appariée. Il faut des méthodes rigoureuses et des échantillons adéquats dans les études qui examinent l'efficacité de l'ITC et les adaptations locales dans divers contextes de soins de santé.