Health Care Utilization in Medically Complex People Living with HIV Before and After Admission to an HIV-specific Community Facility

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Complete List of Authors:	Stewart, Ann; St Michael's Hospital, Family and Community Medicine Antoniou, Tony; St. Michael's Hospital, Department of Family and Community Medicine; Institute for Clinical Evaluative Sciences; Li Ka Shing Knowledge Institute Plumptre, Lesley; Institute for Clinical Evaluative Sciences Graves, Erin; Institute for Clinical Evaluative Sciences Chan Carusone, Soo; Casey House Hospice; McMaster University, Department of Health Research Methods, Evidence, and Impact
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Abstract:	Background: People living with HIV and multiple comorbidities have high rates of health service use. This study looks at system usage before and after admission to a community facility focused on HIV care. Methods: We used Ontario administrative health databases to compare rates of hospital admission, emergency department use, family physician and community care visits among medically complex people with HIV in the year before and after admission to Casey House, an HIV-specific hospital in Toronto, for all individuals admitted between April 2009 and March 2015. To contextualize our findings, we examined rates and costs of health service use among Ontario residents living with HIV. Results: Emergency department use declined from 4.6 to 2.5 visits per person year ($p < 0.0001$) following Casey House discharge, while hospitalization rates declined from 1.4 to 1.1 admissions per person year ($p = 0.05$). Conversely, community care visits and family physician visits increased from 24.3 to 35.6 visits per person year ($p < 0.0001$) and 18.3 to 22.6 visits per person year ($p <0.0001$) in the year post-discharge. These changes were associated with reduced overall costs to the health care system.

	Interpretation: As expected, due to greater medical complexity, health service use and costs for Casey House clients remained elevated compared with the general population of people with HIV. Health care utilization of such complex people living with HIV was significantly different before and after admission to a community hospital focused on HIV care. This has implications for costs to the system.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3,4
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4,5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4,5
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	4,5
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	4,5
Bias	9	Describe any efforts to address potential sources of bias	10,11
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	4-6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	NA
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	4,5
		(*e*) Describe any sensitivity analyses	NA

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	6,7 13, 14
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6, 13
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	NA
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	6,7 13,14
		Cross-sectional study—Report numbers of outcome events or summary measures	NA
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NA
		(*b*) Report category boundaries when continuous variables were categorized	NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7,14
Discussion			
Key results	18	Summarise key results with reference to study objectives	6,7,8,9
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10,11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	8-11
Generalisability	21	Discuss the generalisability (external validity) of the study results	9,10,11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11.12

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Health Care Utilization in Medically Complex People Living with HIV Before and After Admission to an HIV-specific Community Facility

Ann Stewart, MD[1,2]; Tony Antoniou, PhD[1,3,4]; Erin Graves, MSc[4]; Lesley Plumptre, PhD[4]; Soo Chan Carusone PhD [5,6]

[1]Department of Family and Community Medicine, St. Michael's Hospital, [2] University of Toronto, Ontario, Canada; [3]Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, Ontario, Canada; [4]ICES, Toronto, Ontario, Canada; [5]Casey House, Toronto, Ontario, Canada; [6]Department of Health Research Methods, Evidence, and Impact, McMaster University, Hamilton, Ontario, Canada.

Correspondence: Ann Stewart, Ann.Stewart@UnityHealth.to
St. Michael's Hospital, Department of Family and Community Medicine,
c/o Health Centre at 410, 410 Sherbourne St., 4th Flr, Toronto, Ontario, Canada M4X 1K2

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Author Roles: Ann Stewart and Tony Antoniou wrote the manuscript and initiated the research questions. Erin Graves and Lesley Plumptre managed the data abstraction and analysis from the clinical database. Soo Chan Carusone is the research lead at Casey House and provided invaluable support in refining the questions and analyzing the data. All authors critically reviewed the manuscript.

ABSTRACT

Background: People living with HIV and multiple comorbidities have high rates of health service use. This study looks at system usage before and after admission to a community facility focussed on HIV care.

Methods: We used Ontario administrative health databases to compare rates of hospital admission, emergency department use, family physician and community care visits among medically complex people with HIV in the year before and after admission to Casey House, an HIV-specific hospital in Toronto, for all individuals admitted between April 2009 and March 2015. To contextualize our findings, we examined rates and costs of health service use among Ontario residents living with HIV.

Results: Emergency department use declined from 4.6 to 2.5 visits per person year ($p < 0.0001$) following Casey House discharge, while hospitalization rates declined from 1.4 to 1.1 admissions per person year ($p = 0.05$). Conversely, community care visits and family physician visits increased from 24.3 to 35.6 visits per person year ($p < 0.0001$) and 18.3 to 22.6 visits per person year ($p <0.0001$) in the year post-discharge. These changes were associated with reduced overall costs to the health care system.

Interpretation: As expected, due to greater medical complexity, health service use and costs for Casey House clients remained elevated compared with the general population of people with HIV. Health care utilization of such complex people living with HIV was significantly different before and after admission to a community hospital focused on HIV care. This has implications for costs to the system.

INTRODUCTION

Improvements in HIV care have reduced disease-related morbidity and mortality for many people living with HIV.[1-3] However, several studies have demonstrated that these benefits have not been incurred equitably, with medically complex and socioeconomically marginalized people with HIV deriving less benefit from advances in HIV care.[3-9] For these individuals, social and structural barriers to HIV-specific care including comorbid mental health illness, homelessness, food insecurity and poverty converge to create conditions promoting high rates of health service use, including potentially preventable and costly hospital admissions and emergency department visits.[10-13] Yet, while several studies have demonstrated that patients with advanced HIV and patients with co-existing mental health conditions or substance use disorders incur high health care costs,[14-17] there are few population-based studies examining contemporary health service use and associated health care costs of medically and socially complex people with HIV, particularly in settings of universal health care. Moreover, changes in health service use and associated costs following the receipt of specialized tertiary care and comprehensive discharge planning have not been systematically examined.

Casey House is a community hospital in Toronto, Canada which cares for patients experiencing complications of HIV.[18] This 13-bed facility provides both in-House care and ambulatory programs to medically complex and socially vulnerable persons living with HIV. People living with HIV who use Casey House services are referred to as clients, and are cared for by a multidisciplinary team comprising nurses, physicians, social workers and other professionals. Our prior work demonstrated that Casey House clients have a greater comorbidity burden than the general population of Ontario residents with HIV, with a high prevalence of mental health

illness, unstable housing and AIDS-defining opportunistic infections.[18] In addition, linkage to HIV-specific care is suboptimal for these individuals in the period immediately following discharge.[19] In the context of high rates of comorbid disease and suboptimal post-release follow-up with HIV providers, Casey House clients may use acute care services for conditions amenable to outpatient and community-based management. Our objective was to study rates of health service use and associated costs among medically and socially vulnerable people with HIV in the year preceding admission and following discharge to Casey House. We speculated that, because of comprehensive discharge planning, rates of community ambulatory care and home-based services would increase following Casey House discharge, with corresponding declines in the use of acute care services.

METHODS

We used Ontario's administrative health databases to identify people with HIV admitted to Casey House between April 1, 2009 and March 31, 2015. All admissions during this time period were included. The use of data in this project was authorized under section 45 of Ontario's Personal Health Information Protection Act, which does not require review by a Research Ethics Board.

Data Sources

We identified individuals admitted to Casey House using the Canadian Institute for Health Information Discharge Abstract Database (CIHI-DAD), which contains detailed clinical records on all hospital admissions in Ontario. In cases where individuals were admitted on more than one occasion, we studied only the first admission. Individuals included in our primary analysis had universal access to physician services and hospital care, and over 80% had prescription drug

coverage through the Ontario Drug Benefits Plan (ODB). To compare characteristics of Casey House clients with those of the general population of people with HIV, we identified the latter using the Ontario HIV Database, an administrative data registry of Ontario residents with diagnosed HIV infection which was generated using a validated case-finding algorithm.[20] We identified claims for physician services by physician specialty using the Ontario Health Insurance Plan (OHIP) database. We used the Registered Person Database, a registry of all Ontario residents eligible for health insurance, for basic demographic and date of death data. We obtained information regarding hospital admissions and emergency department visits in the year preceding Casey House admission and the year following discharge using the CIHI-DAD and National Ambulatory Care Reporting System Database (CIHI-NACRS), respectively. All datasets were linked using unique, encoded identifiers, and were analyzed at ICES (https://www.ices.on.ca).

Outcomes

Our main outcome was a comparison of health service use and associated costs in the year preceding admission to Casey House and the year following discharge from Casey House. Consequently, the dates of admission and discharge were the index dates for determining pre-admission and post-discharge health service use, respectively. We specifically compared pre-admission and post-discharge rates of hospital admissions, emergency department visits, outpatient physician visits and home care use. We ascertained associated health care costs with a costing algorithm available at ICES to estimate individual-level costs of care.[21] To contextualize our findings, we computed health service use and associated costs of care for Ontario residents with HIV. To do this, we randomly assigned each person from the general population of people

with HIV index dates based on the distribution of admission dates of the Casey House clients, and determined their health service use and associated costs in the year preceding this date.

Statistical Analysis

We summarized patient characteristics using descriptive statistics. We used the Johns Hopkins Adjusted Clinical Groups Case-Mix System to describe the baseline comorbidity burden of Casey House clients and the general population of Ontario residents with HIV. This system uses diagnostic information from administrative databases to describe and predict use of health care resources. In this study, we used Aggregated Diagnosis Groups (ADGs), which are clusters of diagnostic codes that are similar in terms of severity and expected persistence. The number of ADGs ranges from 0 to a maximum of 32, with a higher number reflecting a higher level of co-morbidity.[22] This system has been validated for use in Canadian populations, and both measures are routinely used for case-mix adjustment in health services research.[23,24]

RESULTS

We studied 268 people living with HIV who were admitted to Casey House, between April 1, 2009 and March 31, 2015 (Table 1). The mean age was 48.7 +/- 10.1 years, and 82.8% were male. Compared with the general population of people with HIV, Casey House clients had a greater comorbidity burden (Table 1). In addition, Casey House clients had higher rates of emergency department visits (4.6 vs. 0.7 visits per person year), hospital admissions (1.4 versus 0.1 admissions per person year), specialist visits (46.2 versus 7.0 visits per person year) and

general practitioner visits (18.3 versus 6.3 visits per person year) than the general population of adults living with HIV. Overall, Casey House clients incurred total health care costs that were 5-fold those of the general population of people living with HIV during this period ($56,139.64 versus $11,172.15 per person year), driven largely by costs related to inpatient admissions ($27,166.52 versus $1,431.83 per person year) and emergency department visits ($1,625.22 versus $193.94 per person year).

In our main analysis, we observed a change in health care use among Casey House clients in the year before and after admission (Table 2). Specifically, rates of emergency department visits and hospital admissions declined from 4.6 to 2.5 visits per person year ($p < 0.0001$) and 1.4 to 1.1 admissions per person year ($p = 0.05$), respectively. Similarly, rates of visits to specialist physicians among Casey House clients declined from 46.2 to 31.7 visits per person year ($p = 0.10$) (Table 2). Conversely, rates of general practitioner visits and home care visits increased from 18.3 to 22.6 visits per person year ($p<0.0001$) and 24.3 to 35.6 visits per person year ($p < 0.0001$) respectively.

Changes in service utilization among Casey House clients translated into changes in associated health care costs per person year (Table 2). Overall total healthcare system costs among Casey House clients declined from $56,139.64 to $50,308.63 per person year ($p = 0.19$), with declines in costs associated with emergency department visits ($1,625.22 to $855.67 per person year; $p < 0.0001$), hospital admissions ($27,166.52 to $22,906.16 per person year; $p = 0.25$) and physician billings to OHIP ($5,460.97 to $3,433.63 per person year; $p < 0.0001$). In contrast, spending on home care services ($1,960.53 to $2,735.50 per person year; $p = 0.01$) and publicly funded

prescription drugs ($13,050.01 to $15,408.88 per person year; $p < 0.01$) increased among Casey House clients in the year following discharge relative to the year preceding admission.

DISCUSSION

In our study, we found changes in health care use and associated spending among socially and medically complex people living with HIV following an admission to a specialty HIV hospital. Specifically, rates of hospital admissions, emergency department visits and specialist visits declined in the year following discharge, with corresponding decreases in costs related to emergency department use and physician billings. Conversely, general practitioner physician visits and home care use increased following discharge, with increases in costs for publicly funded prescription medications and home care services.

Despite changes in health service use and decreased health care costs following discharge from Casey House, Casey House clients continued to have greater use of acute care health care services and costs relative to those seen for the general population of people with HIV. This finding likely reflects the greater comorbidity burden of Casey House clients, including a high prevalence of mental health conditions and substance use disorders.[18] Prior research has demonstrated that people with HIV and coexisting mental health conditions have higher rates of health service use and costs relative to people with HIV without mental health conditions. For example, a study of over 14,000 people with HIV who were members of the Kaiser Permanente

Health Northern California health care plan between 1995 and 2010 found higher mean total health costs for people with HIV and concomitant mental health and substance use disorders relative to people with HIV lacking these conditions ($32,881 versus $29,142 per patient per year).[25] Similar findings were observed in a study of people with HIV receiving care through Medicaid, in that costs for people with HIV and serious mental illness exceeded those of people with HIV without these comorbidities ($23,842 versus $13,183 per person).[17] A study of people with HIV who are patients of the US Veterans Health Administration also found that individuals with substance use disorders or psychiatric disorders incurred 59.7% and 49.4%, respectively more cost than individuals who did not have these comorbidities.[16] In addition to a greater comorbidity burden, Casey House clients have more advanced HIV disease, which has been shown to increase health care costs in other studies.[14-16] Finally, Casey House clients face challenges associated with unstable housing, food insecurity and poverty, all of which have been shown in prior studies to increase health service use in people with HIV. Specifically, a study of 347 unstably housed people with HIV found that those with food insecurity were more likely to be hospitalized [adjusted odds ratio (AOR) = 2.16, 95 % confidence interval (CI) = 1.50–3.09] and use the emergency department (AOR = 1.71, 95 % CI = 1.06–2.30) relative to food-secure individuals.[11] In a separate study of health service use of people with HIV and substance use disorder, individuals with homeless experience had 92% more emergency department visits and 113% more hospital admissions than those with no homeless experience.[26] Taken together, we speculate that advanced illness, mental health comorbidity and social determinants of health intersect among Casey House clients to create conditions facilitating greater health service need and costs relative to the general population of people with HIV.

Our study builds upon previous research in several ways. First, our study was conducted in Ontario, Canada, a setting of a single-payer health care model, whereby all people studied would have universal access to medically needed services. Second, because we used provincial administrative health records, we were able to include all individuals in care and record their entire health care trajectory during the study period. Third, we compared changes in health service use and costs following an intervening admission to an HIV specialty hospital providing multidisciplinary care that emphasizes comprehensive discharge planning and connections with providers who can help support social determinants of health such as unstable housing and food insecurity. Although we cannot assume that a causal relationship exists between Casey House admission and the observed changes, it is reasonable to infer that the nature of services provided influenced the nature of health care services used in the year following discharge. Most notably, we speculate that the increase in community physician visits and home care use reflects the provision of appointments to local HIV specialists and home care referrals prior to Casey House discharge. In addition, admission to this supportive community facility may change care pathways due to enhanced allied health team supports, social connection for patients, focused physician evaluation and team encouragement of medication adherence. Ongoing community nurse visits after discharge provide support with medication adherence and physician follow up. These increased community supports may redirect patients from emergency departments to general practitioners, accounting for the decrease in the emergency department use following discharge. We also found significant reductions in costs attributable to physician billings and emergency department use following Casey House discharge. Although some of these declines may be related to deaths of individuals following discharge, the costs incurred by end-of-life care would be accounted for in our calculations.

Several limitations of our study merit emphasis. First, we used administrative health data and did not have access to laboratory data, including viral load and CD4+ cell count. However, prior reviews of medical records of Casey House clients have shown that these people have advanced HIV. In addition, we did not have detailed information on specific determinants of health, such as food and housing instability. However, the finding that over 80% of Casey House clients qualified for provincial drug coverage demonstrates that these individuals represent an especially socioeconomically disadvantaged segment of persons with HIV. Finally, health care use and costs for the general population of people with HIV were derived using randomly generated time periods based on the distribution of admission dates to Casey House among Casey House clients. Consequently, we did not use inferential statistics to formally compare health service use between the groups. Instead, we used data from the general population to provide a benchmark of health service use and costs of care for a typical person with HIV in Ontario over a given year.

CONCLUSION

Patterns of health care use and costs among medically and socially complex people with HIV changed following admission to and discharge from an HIV specialty hospital. Further research examining the mechanisms through which such specialized care affects health care use and other social determinants is necessary to address ongoing gaps in care and further optimize the health of this vulnerable population.

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Potential conflicts of interest. None of the authors have competing interests related to this work. All authors: no reported conflicts of interest. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

Disclaimers. The sponsors had no role in the design or conduct of the study; in the collection, analysis, or interpretation of the data; or in the preparation, review, or approval of the manuscript. The opinions, results, and conclusions reported in this paper are those of the authors and are independent from the funding source. No endorsement by ICES or the Ontario MOHLTC is intended or should be inferred.

Table 1: Baseline characteristics of Casey House clients, admitted between April 1, 2009 and March 31, 2015 and Ontario residents with HIV

Covariate	Casey House (n = 268)	Ontario residents with HIV (n = 19,765)	Standardized Difference
Mean age ± standard deviation (years)	48.7 ± 10.1	46.0 ± 11.6	0.25
Sex			
Female	46 (17.2%)	3971 (20.1%)	0.08
Male	222 (82.8%)	15794 (79.9%)	0.08
Eligibility for provincial drug coverage			
No	32 (11.9%)	10064 (50.9%)	0.93
Yes	219 (81.7%)	8510 (43.1%)	0.87
Over 65 years of age	17 (6.3%)	1191 (6.0%)	0.01
Aggregated diagnosis groups (ADGs)			
Mean ± standard deviation	12.5 ± 4.1	5.6 ± 4.3	1.65
0	1 - 5[#]	3,096 (15.7%)	0.59
1 to 4	3 - 7[#]	5,677 (28.7%)	0.77
5 to 9	47 (17.5%)	7,314 (37.0%)	0.45
10 to 14	129 (48.1%)	3,012 (15.2%)	0.76
>= 15	84 (31.3%)	666 (3.4%)	0.79

[#] These cells have been suppressed in accordance with privacy legislation limiting the reporting of small cell sizes.

Table 2: Rate of health care use and associated costs by Casey House clients (n=268) per person year in the year preceding admission to and the year following discharge from Casey House

	Health care utilization (events per person-year)			Health care cost (CAD[3] per person-year)		
	1 yr prior to adm[1]	**1 yr after D/C[2]**	**p-value**	**1 yr prior to adm**	**1 yr after D/C**	**p-value**
Inpatient hospitalizations	1.4	1.1	0.05	$27,166.52	$22,906.16	0.25
Emergency department visits	4.6	2.5	<0.0001	$1,625.22	$855.67	<0.0001
Physician visits	70.3	58.8	0.04	$5,460.97	$3.433.63	<0.0001
General practitioner	18.3	22.6	<0.0001			
Specialists	46.2	31.8	0.10			
Home care services	24.3	35.6	<0.0001	$1,960.53	$2,735.50	0.01
Publicly funded drugs				$13.050.01	$15,408.88	0.007
Total cost				$56,139.64	$50,308.63	0.19

[1]adm – admission [2] D/C – discharge [3] CAD – Canadian Dollars

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