

# Illnesses Associated With Increased Length of Stay for Individuals Experiencing Homelessness: A Retrospective Cohort Study of Emergency Department Visits and Hospitalizations.

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## Research article

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# Abstract

**Background:** Individuals experiencing homelessness (IEH) tend to have increased length of stay (LOS) in acute care settings, which negatively impacts health care costs and resource utilization. It is unclear however, what specific factors account for this increased LOS. This study attempts to define which diagnoses most impact LOS for IEH and if there are differences based on their demographics.

**Methods:** A retrospective cohort study was conducted looking at ICD-10 diagnosis codes and LOS for patients identified as IEH seen in Emergency Departments (ED) and also for those admitted to. Data were stratified based on diagnosis, gender and age. Statistical analysis was conducted to determine which ICD-10 diagnoses were significantly associated with increased ED and inpatient LOS for IEH compared to housed individuals.

**Results:** Homelessness admissions were associated with increased LOS regardless of gender or age group. The absolute mean difference of LOS between IEH and housed individuals was 1.62 hours [95% CI 1.49 – 1.75] in the ED and 3.02 days [95% CI 2.42-3.62] for inpatients. Males age 18-24 years spent on average 7.12 more days in hospital, and females aged 25-34 spent 7.32 more days in hospital compared to their housed counterparts. Thirty-one diagnoses were associated with increased LOS in EDs for IEH compared to their housed counterparts; maternity concerns and coronary artery disease were associated with significantly increased inpatient LOS.

**Conclusion:** Homelessness significantly increases the LOS of individuals within both ED and inpatient settings. We have identified numerous diagnoses that are associated with increased LOS in IE; these inform the prioritization and development of targeted interventions to improve the health of IEH.

## Background

Homelessness has significant implications for health. Individuals experiencing homelessness (IEH) present with increased disease complications compared to their housed counterparts due to factors such as poor diet, inability to afford medications, and irregular access to primary care [1]. IEH are at higher risk for uncontrolled chronic diseases and have higher prevalence of mental health concerns, addictions, and infectious diseases like Human Immunodeficiency Virus and Hepatitis C [2] [3]. IEH also use acute care services more frequently, with 71% using Emergency Department (ED) services over a 6 month period [4] [5]. They also have increased rates of hospitalizations, due not just to acute medical needs but also because of their complex social barriers [6] [7]. Despite increased rates of hospitalizations, the effectiveness of IEH's hospital stay is diminished by their return to homelessness [8]. Long-term outcomes remain poor for IEH, with mortality rates being up to 9 times higher than the average population [9][10].

Not only are IEH hospitalized more often than housed individuals, they also have longer lengths of stay (LOS) in hospital, which presents an additional burden on both the individual and on society. In general, IEH spend between 2.3 and 4.1 more days in hospital [11][12] [13] than housed individuals, however this

data is aggregate data not identifying which disease types most contribute to this LOS. Hwang et al. noted that in Canada, even after adjustment for age, gender, and resource intensity weight, hospitalizations for IEH cost over \$2500 more than for housed individuals[12]. Concomitant mental health concerns are common in IEH and impact both rates of hospital admissions, LOS, and hospitalization costs [14], with admissions to psychiatry costing over \$1000 more for IEH (even while adjusting for length of stay)[12].

Aside from the presence of mental health conditions, it remains unclear whether specific medical conditions are more likely to lead to an increased LOS in IEH compared to their housed counterparts, information which is crucial to determine targeted interventions to avoid increased LOS. It is often believed that IEH may require longer stays in hospital due to lack of community supports; for example, IEH may spend increased time in acute care setting to receive antibiotics for endocarditis and osteomyelitis due to lack of medication coverage or outpatient parenteral options [15]. In contrast to hospital LOS, there is variable evidence on the impact of homeless on LOS for emergency department visits. One study showed increased ED LOS for IEH[16], while another study specifically examining patients with mental health concerns noted no differences in ED LOS in homeless versus housed individuals[17]. Most studies of ED utilization do not specifically compare LOS, or the differences in ED diagnoses, between IEH and housed individuals[18][19]. A better understanding of how medical diagnoses and needs impact the increased use of both inpatient and ED care can help to identify gaps in our current inpatient and outpatient health service delivery, to ultimately inform the development of interventions to address these specific illness-specific needs [20].

In this cohort study, we aimed to determine the most responsible diagnoses that most affect ED and inpatient LOS among IEH. To our knowledge, this study is the first to assess diagnosis-modifying LOS in this population. This study will deepen our understanding on health issues faced by IEH, and to prioritize and determine disease management strategies in the community.

## Methods

### Study design and population

We designed a retrospective cohort study examining IEH who accessed four tertiary care hospitals and one urgent care center in Calgary, Canada, from April 1, 2017 to March 31, 2018. The exposure was homelessness (operational definition described below). Ethnicity is not recorded within the health region's dataset. If an individual was seen or admitted multiple times, only the first interaction with acute care (ED or inpatient) was utilized to simplify our analysis. The primary outcomes were differences in LOS between IEH and housed individuals within both ED and inpatient settings, with the specific aim of examining which diagnoses and demographics contributed to these differences.

### Data Sources

Administrative data for individuals aged 18 years or greater was provided by the provincial health authority, and consisted of the Discharge Abstract Database (for hospitalizations) and National Ambulatory Care Reporting System database (for ED visits). A unique ICD-10 code (International Classification of Diseases, 10th Revision ) for homelessness was utilized to identify IEH. As this code was only available from 2017 onwards, and as the code for homelessness is optional, additional information regarding homelessness was obtained through individual addresses. If the address was labeled as “no fixed address” or the postal code provided corresponded to one of Alberta’s homeless shelters, the patient was included into the study cohort. Because Calgary homeless shelters tend to be located in the downtown business districts where there are few residential developments, very few regular residences share similar postal codes with the shelters. This method of identifying cohorts of IEH has been used in previous studies [7,8]. Due to limitations in identifying homelessness using administrative databases, individuals who are precariously housed, those with low-income housing, and those who were couch surfing were classified as being housed.

IEH were excluded if their health care identification was missing. If a particular ICD-10 category had fewer than 5 individuals with that diagnosis, they were also omitted due to difficulties with measuring statistical significance. Additionally, significant data outliers defined as individuals who were admitted to hospital for 90 days or more were excluded. The rationale for this latter exclusion criterion is that the extended lengths of stay for these individuals likely represent alternate level of care days[21], where they are medically stable with their admission being no longer attributable to acute care management.

## **Statistical Analysis**

Once IEH were identified in the database, ICD-10 codes were used for the classification of the primary diagnosis these clients were evaluated for in acute care. ICD-10 code subcategories were combined for most diagnoses. If an individual diagnoses had a small sample size less than 5, they were omitted from analysis. The mean LOS for IEH and housed individuals (HI) within the ED and inpatient settings were calculated separately, and mean differences between these two were calculated by subtracting the mean LOS for IEH by the mean LOS for HI. Mean differences in LOS were adjusted for age group, sex as well as diagnosis based on principal diagnosis using analysis of covariance to limit confounding effects [22][23]. 95% confidence intervals (CI) for the difference in mean LOS were determined using the Student *t* statistic. Statistical Analysis Software (SAS) version 9.3 was used to perform all statistical analyses.

The study received ethics approval at the University of Alberta research ethics board as well as internal research review by Alberta Health Services.

## **Results**

A total of 3,620 unique IEH accessed an acute care facility in 2017-18; 858 of these individuals were admitted to the hospital. Our comparator group consisted of 375,271 housed individuals.

# Characteristics of IEH and differences in LOS in acute care settings

The majority of individuals assessed in both the ED and inpatient settings were male across all age groups (Table 1). The mean age of IEH using acute care resources was 38.6 years, and 48.5 years for housed individuals. Most IEH who used acute services were between the ages of 25–49, whereas age ranges were more evenly spread for housed individuals. Among IEH who accessed acute care, the average number of ED visits over one year was 3.19 compared to 1.28 visits for housed individuals. On average, homeless and housed individuals had a similar number of hospital admissions over the 1 year period, however, the LOS for IEH patients was over 1.5 fold that for housed individuals (10.27 vs. 6.70 days,  $p < .0001$ ).

Table 1  
Patient characteristics, stratified by housing status

	Homeless (n = 3620)	Housed (n = 375,271)	P-value
Sex			
Male %	74.14%	45.02%	< 0.0001
Female %	25.86%	54.98%	
Age (year)			
Mean	38.55	48.54	< 0.0001
18–24	12.73%	10.29%	< 0.0001
25–34	31.82%	20.38%	
35–49	33.18%	24.15%	
50–64	19.34%	21.73%	
65+	2.93%	23.45%	
Mean Number of Emergency Department visits based on first visit over 1 year	3.19	1.28	
Mean Length of Stay in Hours within Emergency Departments	6.62	4.95	< 0.0001
Mean Number of inpatient admissions based on first admission over 1 year	0.36	0.30	
Mean Length of Stay in Days within inpatients	10.27	6.70	< 0.0001

Table 2 shows the adjusted mean LOS, stratified by age and sex. There were 2.84 times more males seen in the ED and 2.97 times more males admitted to hospital than females, which reflects the Calgary homeless population baseline demographic of 2.77 times more males than females [24]. IEH in almost all age groups spent statistically significantly more time in both the ED and in hospital than housed individuals. There was no statistically significant difference in LOS for IEH and housed individuals older than 65 years of age. Males experiencing homelessness between the ages of 18 and 25 had the highest mean difference in their LOS, spending 2.79 [CI 2.30–3.27] more hours in EDs on average, as well as 7.12 [CI 4.55–9.69] more days in hospital compared to their housed counterparts. Similarly, females experiencing homelessness between 18 and 25 years of age had the highest mean difference in ED LOS, at 3.28 [CI 2.79–3.78] more hours compared to housed individuals. Females experiencing homelessness between 25 and 34 years of age spent 7.32 [CI 6.41–8.22] more days admitted to inpatient wards compared to their housed counterparts. On average, IEH spent 1.62 [CI 1.49–1.75] more hours in the ED and 3.02 [CI 2.42–3.62] more days in hospital compared to housed individuals.

Table 2

Differences in mean emergency department and hospital lengths of stay between individuals experiencing homelessness versus housed individuals, stratified by age and gender

<b>Age Group</b>						
	<b>&lt;25</b>	<b>25–34</b>	<b>35–49</b>	<b>50–64</b>	<b>65+</b>	<b>Grand Total</b>
<b>All Patients</b>						
Total IEH seen in ED	363	894	910	519	76	2762
Aggregate Difference in Mean ED Length of Stay for homeless versus housed individuals [95% CI], hours	2.97 [2.64–3.33]	2.74 [2.55–2.92]	2.41 [2.24–2.59]	1.28 [1.01–1.56]	0.49 [-0.60 to 1.58]	1.62 [1.49–1.75]
	<b>P-value &lt; 0.0001</b>	<b>P-value &lt; 0.0001</b>	<b>P-value &lt; 0.0001</b>	<b>P-value &lt; 0.0001</b>	<b>P-value 0.3795</b>	<b>P-value &lt; 0.0001</b>
Total IEH admitted to hospital	98	258	291	181	30	858
Aggregate Difference in Mean Hospital Length of Stay for homeless versus housed individuals [95% CI], days	6.63 [5.07–8.20]	5.37 [4.70–6.05]	3.84 [3.03–4.65]	3.91 [2.77–5.05]	1.30 [-2.37 to 4.96]	3.02 [2.42–3.62]
	<b>P-value &lt; 0.0001</b>	<b>P-value &lt; 0.0001</b>	<b>P-value &lt; 0.0001</b>	<b>P-value &lt; 0.0001</b>	<b>P-value 0.4879</b>	<b>P-value &lt; 0.0001</b>
<b>Female</b>						
Total Female IEH seen in ED	135	263	203	104	15	720
Difference in Mean ED Length of Stay [95% CI], hours	3.28 [2.79–3.78]	2.70 [2.40–3.01]	2.11 [1.76–2.47]	1.62 [1.06–2.18]	0.76 [-2.14 to 3.65]	1.72 [1.48–1.96]
	<b>P-value &lt; 0.0001</b>	<b>P-value &lt; 0.0001</b>	<b>P-value &lt; 0.0001</b>	<b>P-value &lt; 0.0001</b>	<b>P-value 0.6093</b>	<b>P-value &lt; 0.0001</b>
Total Female IEH admitted to hospital	40	74	60	37	5	216

<b>Age Group</b>						
Difference in Mean Hospital Length of Stay [95% CI], days	5.88 [3.85–7.91] P-value < 0.0001	7.32 [6.41–8.22] P-value < 0.0001	5.77 [4.29–7.26] P-value < 0.0001	4.22 [1.61–6.84] P-value 0.0016	-0.59 [-11.93 to 10.75] P-value 0.9187	3.83 [2.67–5.00] P-value < 0.0001
<b>Male</b>						
Total Male IEH seen in ED	228	631	707	415	61	2042
Difference in Mean ED Length of Stay [95% CI], hours	2.79 [2.30–3.27] P-value < 0.0001	2.75 [2.51–2.99] P-value < 0.0001	2.50 [2.28–2.71] P-value 0.0001	1.19 [0.86–1.52] P-value < 0.0001	0.45 [-0.75 to 1.64] P-value < 0.0001	1.59 [1.43–1.74] P-value < 0.0001
Total Male IEH admitted to hospital	58	184	231	144	25	642
Difference in Mean Hospital Length of Stay [95% CI], days	7.12 [4.55–9.69] P-value < 0.0001	4.54 [3.13–5.95] P-value < 0.0001	3.31 [2.17–4.46] P-value < 0.0001	3.83 [2.59–5.07] P-value < 0.0001	1.54 [-2.14 to 5.23] P-value 0.4113	2.75 [2.02–3.49] P-value < 0.0001

## Length of Stay based on diagnosis in ED and inpatients

Table 3 shows all primary diagnoses that were found to be associated with a statistically significant increase in LOS for IEH in the ED compared to their housed counterparts. Some key diagnoses that were associated with an increased ED LOS in IEH were fever with chills (mean difference of 9.81 hours [95% CI 5.01–14.61]) and synovitis /tenosynovitis (mean difference of 6.19 hours [95% CI 5.01–7.38]). IEH who presented with unspecified organic psychosis and schizophrenia had a mean difference in LOS of 15.47 [95% CI 13.30–17.65] and 15.33 [95% CI 13.43–17.22] more hours respectively compared to housed individuals.

Table 3

Mean difference in emergency department lengths of stay in between individuals experiencing homelessness versus housed individuals, adjusted for age and gender

Presenting Complaint in Emergency Department based on ICD-10 codes.	Homeless	Housed Individuals	Mean Difference (hours) (95% CI)	Wilcoxon Rank Sum
	Mean LOS (hours)	Mean LOS (hours)		P-value
Skin and subcutaneous infections/Cellulitis (L02,L03,L08,L98)	5.00	3.51	1.49 [1.12–1.86]	< .0001
Injury to the Wrists, hand and forearm (S61, S62, S51, S60, S52, S50)	3.17	2.24	0.93 [0.61–1.25]	< .0001
Issue of repeat prescription (Z76)	2.32	1.93	0.39 [0.07–0.72]	< 0.0158
Pneumonia Unspecified (J18)	8.76	6.59	2.17 [0.58–3.76]	0.0074
Fracture superficial of lower leg and injury of ankle ( S82, S90, S80, S81)	7.81	4.65	3.16 [1.79–4.53]	< .0001
Intracranial and fracture of skull ( S02, S06)	6.87	4.50	2.36 [1.42–3.31]	< .0001
Mental and behavioural disorders due to use of opioids ( F11)	6.22	4.60	1.63 [0.76–2.50]	0.0002
Unspecified nonorganic psychosis (F29)	22.06	6.59	15.47 [13.30–17.65]	< .0001
Schizophrenia (F20)	19.83	4.50	15.33 [13.43–17.22]	< .0001
Symptoms and signs involving emotional state or Nervousness (R45)	10.22	6.04	4.18 [2.75–5.61]	< .0001
Attention to surgical dressings and sutures (Z48)	2.05	1.74	0.31 [0.03–0.59]	0.0295
Convulsions and Epilepsy (R56, G40)	6.92	4.54	2.39 [0.84–3.93]	0.0026

<b>Presenting Complaint in Emergency Department based on ICD-10 codes.</b>	<b>Homeless Mean LOS (hours)</b>	<b>Housed Individuals Mean LOS (hours)</b>	<b>Mean Difference (hours) (95% CI)</b>	<b>Wilcoxon Rank Sum  P-value</b>
Acute upper respiratory infections of multiple and unspecified sites (J06)	3.55	2.44	1.12 [0.54–1.69]	< .0001
Blood-alcohol and blood-drug test (Z04)	3.01	3.94	-0.93 [-1.49 to -0.38]	0.0010
Depressive episode (F32)	8.17	10.73	-2.56 [-4.78 to -0.34]	0.0239
Acute pharyngitis (J02)	6.32	5.04	1.28 [1.05–1.51]	< .0001
Fracture of foot, except ankle (S92)	5.51	3.05	2.46 [1.48–3.44]	< .0001
Dislocation, sprain and strain of joints and ligaments at ankle and foot level (S93)	3.10	2.23	0.87 [0.47–1.28]	< .0001
Diarrhea and gastroenteritis of presumed infectious origin (A09)	7.41	5.49	1.92 [0.28–3.56]	0.0221
Synovitis and tenosynovitis (M65)	8.42	2.22	6.19 [5.01–7.38]	< .0001
Hemorrhage in early pregnancy (O20)	6.35	4.22	2.13 [0.18–4.07]	0.0319
Fever with chills (R50)	17.32	7.51	9.81 (5.01–14.61)	< .0001
Urinary tract infection, site not specified (N39)	6.80	4.56	2.24 [0.05–4.43]	0.0452
Follow-up care involving removal of fracture plate and other internal fixation device (Z47)	2.19	1.71	0.48 [0.14–0.81]	0.0049

Presenting Complaint in Emergency Department based on ICD-10 codes.	Homeless	Housed Individuals	Mean Difference (hours) (95% CI)	Wilcoxon Rank Sum
	Mean LOS (hours)	Mean LOS (hours)		P-value
Dislocation, sprain and strain of joints and ligaments of knee (S83)	3.50	2.52	0.98 [0.12–1.83]	0.0251
Foreign body in ear (T16)	2.80	1.68	1.11 [0.21–2.02]	0.0160
Dermatophytosis (B35)	3.85	1.75	2.10 [1.13–3.06]	< .0001
Open wound of hip and thigh (S71)	4.71	2.63	2.08 [0.22–3.93]	0.0282
Injury of eye and orbit (S05)	4.92	2.35	2.57 [1.75–3.38]	< .0001
Injury to the neck (S19)	8.22	3.57	4.65 [2.41–6.88]	< .0001
Acne Keloid (L73)	4.23	2.04	2.19 [0.98–3.41]	0.0005

There were two diagnoses found to incur statistically significantly longer ED LOS for housed individuals compared to IEH; these included depression (mean difference of -2.56 hours [95% CI -4.78 to -0.34] hours) and blood alcohol and blood drug test (-0.93 hours [95% CI -1.49 to -0.38]).

Within the inpatient population, only two diagnoses demonstrated a statistically significant increased LOS in IEH compared to housed individuals. IEH diagnosed with atherosclerotic cardiovascular disease had an average of 25.33 [6.55–44.12] more days in hospital compared to housed individuals. The mean LOS for IEH with this diagnosis was 33.4 days vs 8.07 days for housed individuals. IEH with a most responsible diagnosis of preterm delivery spent an average of 6.45 [4.33–8.57] more days in hospital.

## Discussion

To our knowledge, this is the first study that explores differences in LOS between IEH and housed individuals in both the ED and inpatient setting. It is also the first study to explore how these differences vary by demographics and the principle diagnoses that prompted acute care use. In keeping with previous studies, we found that a disproportionately high prevalence of IEH in the ED and admitted to hospital were men between the ages of 25 and 34, where the majority of individuals experiencing homelessness in

the community are between the ages of 45–64 [24]. Most were admitted to hospital for substance-related concerns. On average, IEH spent 1.62 more hours in the ED and 3.02 more days in hospital than housed individuals. This average increase in inpatient LOS for IEH is slightly lower than a previous study from New York (where LOS for IEH was 4.1 more days than for housed individuals) but is in keeping with a Canadian study which found a mean difference of 2.32 days in LOS between IEH and those who are housed [11–12].

The trend towards increased ED and hospital LOS was consistent across many diagnoses, many of which have little physiologic or clinical overlap. This suggests that the increased LOS in IEH may be more attributable to their underlying state of homelessness rather than factors related to the particular medical diagnoses. There were surprisingly two diagnoses that were associated with increased LOS for HI compared to IEH including depression, and blood alcohol and drug tests. These differences appear small and of questionable clinical significance.

By exploring the differences in ED LOS, our study highlights potential points of intervention to optimize ED workflow and bed occupancy. Within ED, IEH contribute to reduced work flow, leading to ED crowding which has been associated with decreased quality of care, delays in treatment commencement, and increased mortality [25]. The majority of the primary diagnoses that are most frequently seen in the ED in the homeless population might be managed in an outpatient setting, though we are limited by the lack of severity data captured in administrative databases. For example, both cellulitis and epilepsy were associated with an increased ED LOS for IEH. These are ambulatory care sensitive conditions (ACSC) [26] where acute care use might be avoided if they able to be optimally managed in the outpatient setting. A large number of diagnoses associated with increased ED LOS are related to mental health and addiction concerns. Further investment into community based mental health and addictions resources may be warranted.

When looking at diagnosis associated with increased LOS within inpatients; coronary atherosclerotic disease (CAD) is associated with almost 25 more days spent admitted to hospital compared to housed individuals. While CAD is not classified as an ACSC, risk factors for CAD such as hypertension and diabetes, as well as their consequences such as angina and heart failure are included in ACSC. Furthermore, smoking is a known risk factor for CAD. There is a very high prevalence of smoking amongst IEH (57%) compared to housed individuals (27%) [27]. Our results highlight the need for interventions targeting CAD and their risk factors in IEH, such as focusing on resources for smoking cessation, hypertension, and diabetes. Maternal concerns associated with homelessness also demonstrated increased LOS with 6.45 more days spent in hospital, again demonstrating specific needs for community prenatal and fetal-maternal care for IEH.

The strengths of our study include detailed hospitalization and ED data collected from multiple acute care facilities. Furthermore, our findings are in keeping with prior evidence, suggesting that they are generalizable. The demographics of the Calgary population experiencing homelessness has also been demonstrated to be similar to IEH across the country [28][29].

There are limitations to our study. Due to our cohort identification methods, a small number of IEH were excluded from our study. For example, individuals without identification were excluded, though this comprised only 1/30 of our sample size. Furthermore, as we could not identify individuals who were precariously housed such as those who were couch surfing, our cohort likely represents individuals more severe or chronic homelessness. Another limitation was our inability to account for illness severity, despite matching IEH and controls based on demographics and primary diagnoses, as this information is not captured within the administrative databases. That is, IEH may present to acute care facilities with similar diagnoses as housed individuals, but at a later stage and/or with increased severity, which could also explain their increased lengths of stay.

## Conclusion

Homelessness is associated with increased ED and hospital inpatient LOS. No one diagnosis or diagnosis group could explain the increased LOS for IEH, suggesting that underlying homelessness itself contributes to this issue. Efforts to reduce homelessness and address the social determinants of health are likely necessary to have any impact on reducing acute care utilization in this population.

## Abbreviations

ACSC Ambulatory care sensitive conditions

CAD Coronary Artery Disease

CI: Confidence Intervals

ED: Emergency Department

ICD-10: International Classification of Diseases 10<sup>th</sup> Revision.

IEH: Individuals experiencing homelessness

LOS: Length of Stay

SAS: Statistical Analysis Software

## Declarations

- Ethics approval was obtained for this study. As this was a large data study, consent to participate was not deemed necessary from ethics.
- The authors of this article consent to its publication
- All data and materials used in this manuscript are from The Alberta Health Services central data repository.

- The authors of this article declare no competing interests.
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